The Welding Engineer

Reg. U. S. Pat. Office

ume XXI | May, 1936 | Number 5

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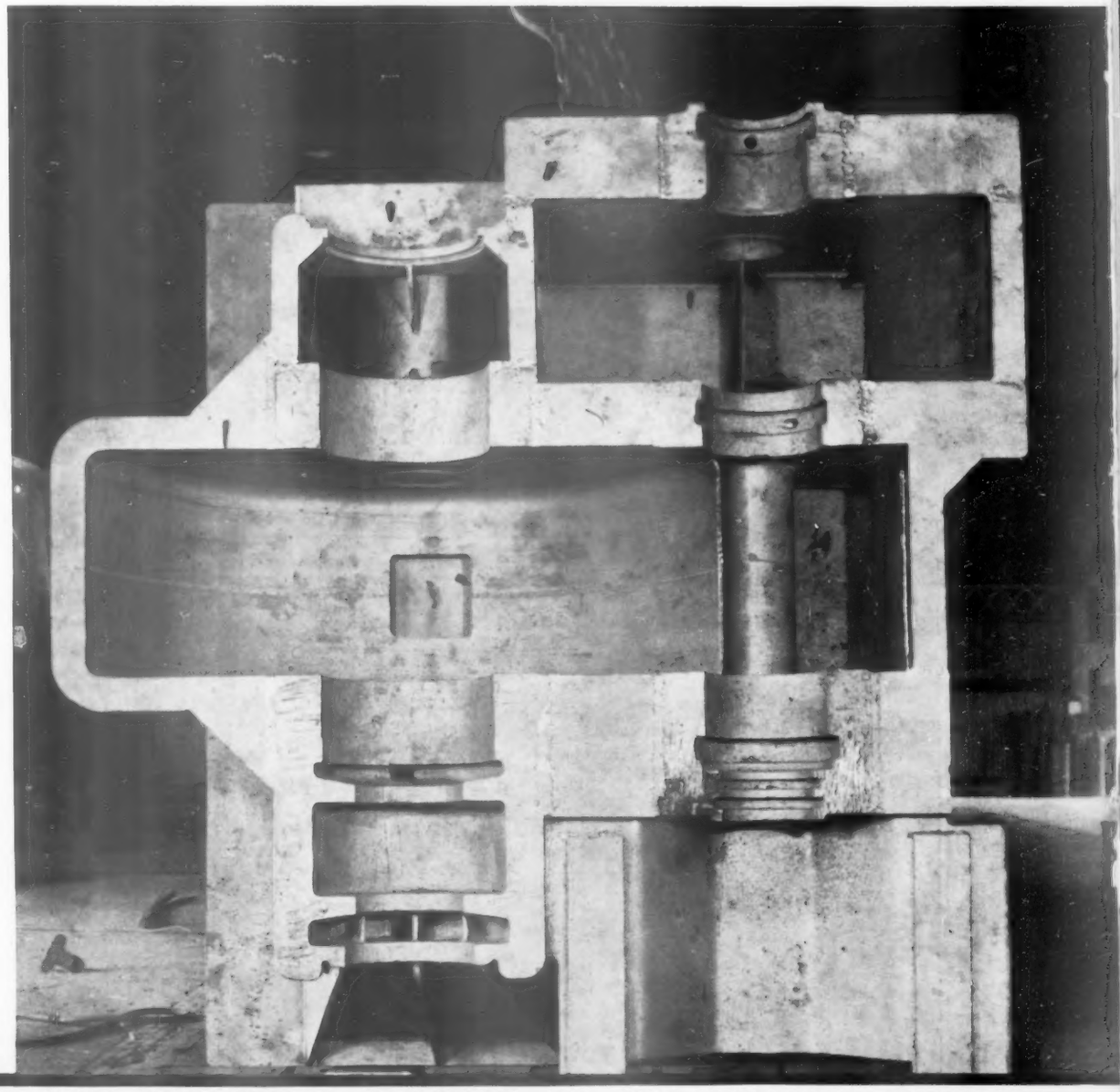

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THE WELDING ENGINEER

Vol. 21, No. 5 MAY, 1936

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G. H. MACKENZIE, *President and Treasurer*
F. L. SPANGLER, *Editor* L. C. MONROE, *Advertising Manager*

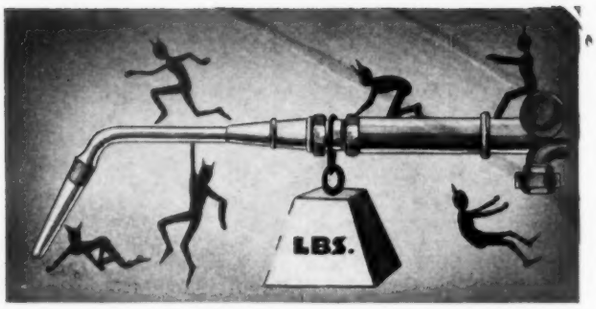
Representatives

EASTERN: T. E. Depew, American Circle Bldg., New York, N. Y. Tel. Columbus 5-7843. PACIFIC COAST: W. R. McIntyre, 311 Architects Building, Los Angeles, Calif. Tel. Michigan 2561.

Subscription, payable in advance: United States and possessions, and Canada, $3 a year; Foreign Countries, $4 a year; Single copy, domestic, 25 cents; Single copy, foreign, 35 cents. Entered as second-class matter January 20, 1916, at the postoffice at Chicago, Illinois, under the act of March 3, 1879.

FOREIGN REPRESENTATIVES: AUSTRALIA and NEW ZEALAND—R. Hill, Matlock House, Davenport, Auckland, New Zealand; SOUTH AFRICA—J. W. Arnison, 35a Victoria Avenue, Benoni, Transvaal, South Africa; JAPAN—Maruzen Company, Ltd., 6, Nihonbashi, Tori-Nichome, Tokyo, Japan; U. S. S. R.—Mesdunarodnaja Kniga, Kusnezkij Most 18, Moscow, U. S. S. R.

Published on the 15th of each month by the Welding Engineer Publishing Company, 608 S. Dearborn St., Chicago, Ill. Telephone Webster 7134.



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EDITORIAL

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More Operators Needed

● For the past several years, many good welding operators have had to find part-time welding jobs to keep themselves employed, with wages below living standards.

In the last three months, the situation has radically changed. The operator is now in his hey-day, all because the demand for his services has suddenly risen to such heights that employers are bidding against each other in order to get good operators and keep them.

Wise and judicious employers pay good wages for good help, even in bad times. But many welding operators have had to work for 60 or 50 cents an hour, and even lower, in order to keep fed and clothed. Good operators are worth more than that to their employers, even in worst times. Such wages can't be justified, even by economic considerations.

Insofar as the present shortage of welders has corrected this wage condition, no broad-minded employer will begrudge the scarcity of welding operators.

But if the situation becomes acute, the result may have unfavorable repercussions to welding—and if that occurs, all welding operators, good and poor, will suffer along with all others who use welding as a means of economical fabrication or depend on it for a livelihood.

Anybody can lay a weld bead—but that doesn't make a welder. There are still many men, young and old, out of work. Will those industries who are hard pressed to obtain welding operators turn to men of little or no training to manipulate the arc and torch? If so, there will be a lowering of the bars to poor welding—and then we shall all pay the piper.

Every user of welding should be vitally concerned in this matter. Trade associations and technical societies should urge the training of more operators. Schools who stand to profit from the situation should particularly feel their responsibility to maintain a qualified teaching staff, accept only applicants of good education and character, eliminate "guarantees" (a catch-word that applicants are getting wise to), and stick strictly to provable facts in promoting the school.

Welding schools being operated for profit need a good housecleaning. There are exceptions in the case of a few schools who have conducted their business on a high plane. Unless the schools take it upon themselves to make needed corrections, trade groups may be obliged to establish their own schools to obtain trained men, or to work through public vocational schools.

The commercial welding schools today have the biggest opportunity of their life, but have they the vision to grasp it?

The Owen

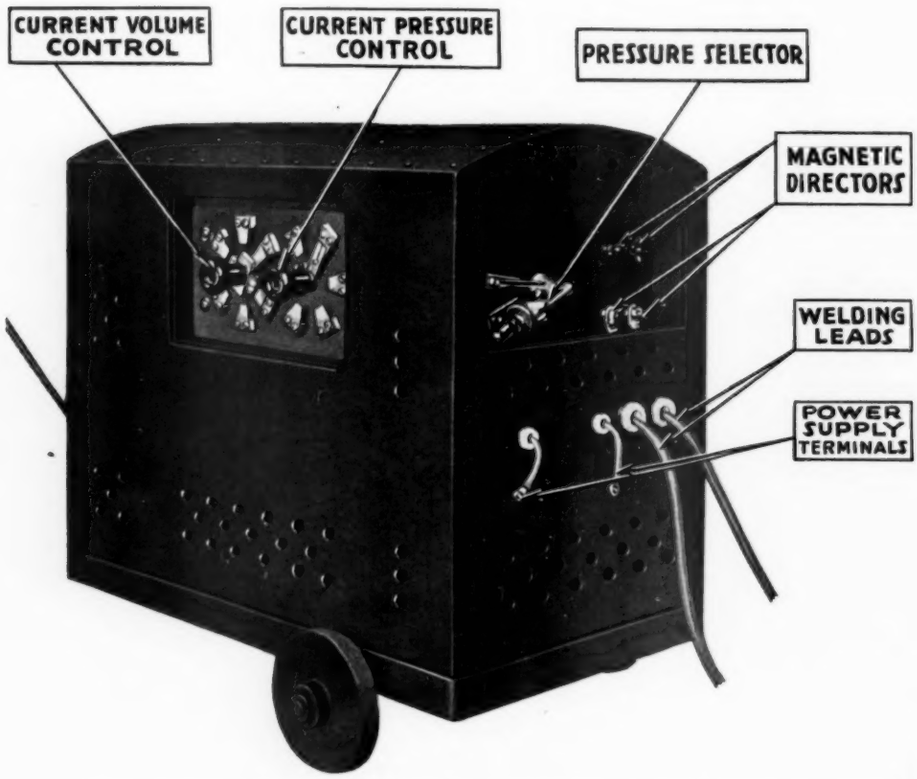
ALTERNATING-CURRENT WELDE

The Owen Type H Electric Welder is superior, in every class of welding, to any ot Electric Welder (A.C. or D.C.) now on the market.

The Owen possesses the outstanding feature of

WELDING - IN - CONTACT

with many types of Coated Electrodes now in general use.



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GREATER METAL RANGE

Without Any

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ABSOLUTE GUARANTEE

Continuous Welding 55° C	Nominal Open Circuit Volt	ARC Voltage	Electrode Range
Machine No. 1	40-60	15-40	1/32 to 1/8
Machine No. 2	40-60	15-40	1/16 to 5/32
Machine No. 3	40-60	15-40	1/16 to 1/4
Machine No. 4	40-60	15-40	1/16 to 3/8

PATENTS. The **OWEN** Alternating-C Welders are manufactured under the follo United States Patents issued to Frederick C. O 1604069; 1619629; 1619753; 1634959; 1637237; 1 1644604; 1647928; 1654382; 1651223; 1659469; 1 1671839; 1677003; 1679263; 1690943; 1836615. C PATENTS PENDING.

Ask for Bulletin No. 1-36

OWEN ELECTRIC COMPANY

1825 - 14th Street, WASHINGTON, D. C.

The Welding Engineer

VOLUME XXI | MAY, 1936 | NUMBER 5

Chronic Trouble at Pipeline Junction Ended by Welding . . .

By ELTON STERRETT

THE first time a certain 6-in. delivery branch in Texas broke through the weld at its entrance into the 8-in. main line, the trouble was laid to shifting of the larger pipe, and the break was rewelded.

With a second break, also while handling East Texas crude oil under a pump pressure of 900 lb. per sq. in., it began to look as though this particular 45° weld was destined to become a maintenance "hot-spot", and a small swatch was cut from the line at the weld and its metal examined.

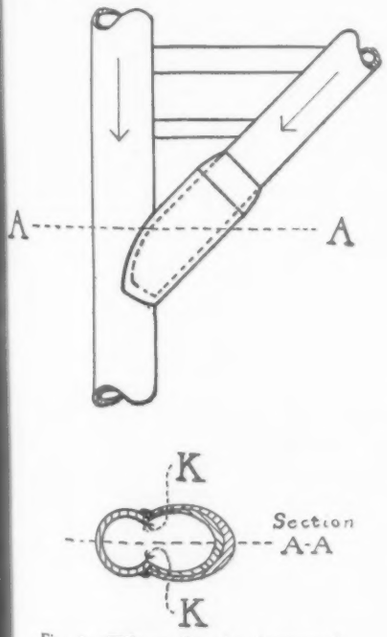


Fig. 1—**Where Breaks Occurred.**

Grain size and arrangement clearly indicated fatigue—crystallization of the steel through repeated stress reversals. It was necessary to look no further than the twin duplex plunger pump 30 ft. away at the end of the 6-in. pipe for the source of these vibrations; as, at 35 r.p.m., there are in excess of 200,000 pulsations in pressure sent through the line each working day by the pump. Likewise, as this pulsation travels undamped through the fluid at nearly the speed of sound (in the case of this particular pipe, at the rate of 4,185 ft. per second) it is practically as though each plunger impact was transmitted directly to the troublesome junction.

Pump Impulses Bend Junction of Pipes With Hinge-Like Action

Sketching the intersection, and taking a section through *A-A*, Fig. 1, where both breaks occurred, it appears in the subjoined view that there are two spots, *K K*, one above and the other below the horizontal axis, in which this severe pressure is counteracted only by the resistance to bending of the metal bridging from each pipe wall. The structure is roughly that of a groined arch, against which both main-line and excess plunger pressure act to tend to straighten the joined surfaces. Between plunger impacts this deformation tends to return to its former shape, a hinge-like action taking place with each impact.

Once this fact was appreciated, it was apparent that renewing the junction in its original form was simply inviting a recurrence of the break. To get around this structural weakness, a sleeve of 8-in. pipe was formed, with an oxyacetylene cutting torch, to fit snugly against the main line, and its outer end swaged down to contact the 6-in. pipe.

The Sleeve in Place

(The two tie rods maintain alignment of both lines and divide the strain with the stiffening sleeve.)

After the break was filled in with the arc, this sleeve, after being split into halves longitudinally for ease in placing, was arc welded in place, the longitudinal seams closed, and then a second bead was run over all welds to insure tightness against line pressure, even should the inner weld fail.

When this outer or reinforcing sleeve is sketched around the intersection at *A-A* it is apparent that the bending of the metal at *K K* is restricted to the narrow strip between the two welds, or

must be carried on out into the circumference of the pipe, there to meet no restriction or change in contour to form a node around which destructive crystallization may center.

As soon as the hole in the original junction was plugged with the arc, pressure was gradually built up on the line and held at 400 lb. per sq. in. while the sleeve was being welded in place. The entire welding time was 2 hours and 20 minutes, two welders working, one forming the sleeve with the torch while his mate plugged the leak, and both teaming to "sew" the sleeve in place.

"Hot-spots" such as this can usually be avoided by proper design, abandoning slight angular welds in favor of 90° tie-ins when possible, as that method has the least possible metal which does not lie in a true and complete cylinder. But, as in this instance, where unfavorable conditions are encountered, a study of the joint and attention to strengthening its weaknesses will render serviceable many a designer's mistake or oversight.

Meetings

Chicago

"Weld Testing and Inspection" is the general topic assigned for the meeting of the Chicago Section, American Welding Society, to be held on Friday night, May 22, at 8 p. m., at Mission Hall, Armour Institute of Technology, with the following subjects and speakers: "Determining the Qualities of Fusion-Welded Joints," by E. R. Fish, vice-president, American Welding Society, and chief engineer of the boiler division, Hartford Steam Boiler Inspection & Insurance Co., Hartford Conn. "The Importance of Reliable Weld Testing," by C. E. Plummer, of Robert W. Hunt Co., Chicago, who will discuss tests on carbon steels and alloy steels, including several new methods of making tests. "Effects of Codes and Regulations," by E. B. McGuire, general manager, Hamler Boiler & Tank Co., Chicago.

The meeting will be preceded by the last of a series of lectures on "Metallurgy as Applied to Welding," by Jules Muller, at 7 p. m., and by the teller's report on the election of officers. A dinner will be served at 6 p. m. on the same floor of the Mission Building.

A demonstration of a. c. welding of 24-gauge sheets and larger will be given by R. B. Davidson, Chicago branch manager of K. O. Lee & Son, and R. McDonald, of the same company, at the Welders Information Center, 741 West 70th St., on Tuesday, June 2, at 8 p. m. Also, E. J. Shuler will talk on the melting points of electrode slags and will demonstrate aluminum welding with the arc.

At a meeting of the Western Society of Engineers held on May 13 in the Engineering Building, Jonathan Wolfe, assistant superintendent of track and roadway, Chicago Surface Lines, gave a talk on "Track Welding Practices."

Dallas

Among papers of interest to the welding field, to be presented at the semi-annual meeting of the American Society of Mechanical Engineers, to be held at Hotel Adolphus, Dallas, Texas, June 15 to 20, are the following: "The use of the X-Ray Testing of Welded Vessels," by H. R. Isenburger, and "The Spraying of Molten Metal," by L. E. Kunkler, both of which are scheduled for the machine-shop session at 3:15 p. m. on Wednesday, June 17. On the following morning, at 9:30 a. m., discussions will be held on the ASME-API code and corrosion of pipelines.

Detroit

An illustrated lecture on the "Story of Electric Welding in the Automotive Industry," was given by Otto Dinger, of the Dodge Division of Chrysler Motor Corp., on Apr. 22, at a joint meeting of the Detroit Section, American Welding Society and the American Institute of Electrical Engineers.

New York City

Two motion-picture films will be shown at the meeting of the New York Section, American Welding Society, to be held at 8 p.m. on Tuesday evening, May 26, in the Engineering Societies Building, 33 West 39th St. New officers of the Section will also be installed.

One of the films is a high-speed motion picture of the electric arc, which is slowed down in reproduction so that the action of the arc, deposition of the metal, and formation of the slag can be better visualized. Both the d.c. and a.c. arc and the atomic-hydrogen are as shown, both bare and heavy-coated electrodes being used. The film is furnished by the General Electric Co.

The other film is entitled "Heavy Machine Cutting With the Oxyacetylene Process," and is furnished by The Linde Air Products Co.

Philadelphia

An inspection trip to the plant of the Edward G. Budd Manufacturing Co. was held on the afternoon of May 18 by the Philadelphia Section, American Welding Society, which took the place of the regular May meeting. The trip was preceded by a luncheon at the Engineers Club.

San Francisco

A meeting of the San Francisco Section, American Welding Society, was held at the Oakland Airport, in Oakland, on Apr. 25. A feature was an interesting talk by A. F. Boonalie, former World War ace, who is now Director of Technical Instruction at the Boeing School of Aeronautics, on the subject "Incidents in Aviation." Following the dinner session, an inspection trip was made through the United Air Lines and the Boeing School facilities at the Oakland Airport, after which the following papers were presented: "Design for Welded Aircraft," by Walter McGinty; "Aircraft Welding and Construction," by David Retan; and "Welding in Aircraft Maintenance," by H. R. Brentlinger. Each paper was followed by an open discussion. The business of electing and installing new officers for the ensuing year was also completed.

Welding Fly-Wheel Teeth Gets Starter Business

By R. B. HUTCHISON

A 10 to 20 job a week business in welding flywheel starter teeth is a profitable sideline for the Totten Battery & Welding Co., 3001 Gillham, Kansas City, Mo.

"Prices are quoted as low as $2 and $2.50 for four and eight teeth," says Ben B. Brown, welder, "but that is used for a leader, as you will hardly ever find as few as eight teeth out. Any number of teeth over 15 is $3.50, and most of them run to that. On fours there are 25 to 30 teeth out and on sixes I have welded in as many as 45."

However, the customer is always given the opportunity to count the number of teeth needing welding before a job is done. The number usually surprises him enough that he does not object to the higher price.

"We always remove the starter before going to work, and show that to the customer too," Mr. Brown continued. "It's a safe bet if the flywheel teeth are chewed up the starter was at fault, and in over 90 per cent of the cases we sell new Bendix springs, shafts or gears, or a commutator-turning job. We charge a flat rate of $2.50 on starter repairs of this kind. Of course if the armature has to be rewound we charge extra for that."

All welding is done from the bottom and has to be done rapidly, using a light torch. Quarter-inch cast-iron or steel rod is used, according to the material in the teeth. No grinding is done, and preheating is accomplished with the welding torch.

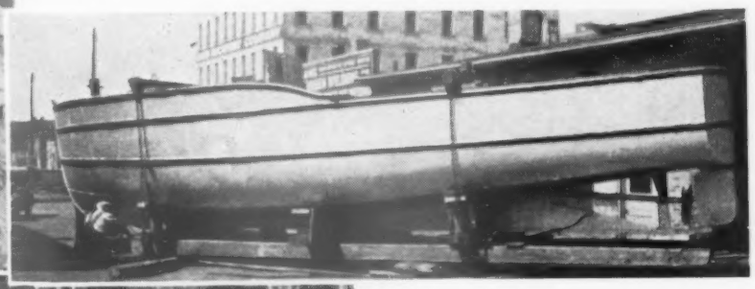
Open flywheels are easier and there is no dirty oil and grease to catch fire, according to Mr. Brown. But in no case is the engine or flywheel pulled.

When the flywheel housing interferes a square of it is cut out with the torch and welded back in when the work on the teeth is completed.

Welding News in Pictures

• (Left) Rising out of the Arizona desert is a monument, the epitaph of which is written with the welding arc. Hi Jolly was caretaker of a camel herd brought to this country in 1856. (Photograph courtesy of The Lincoln Electric Co.)

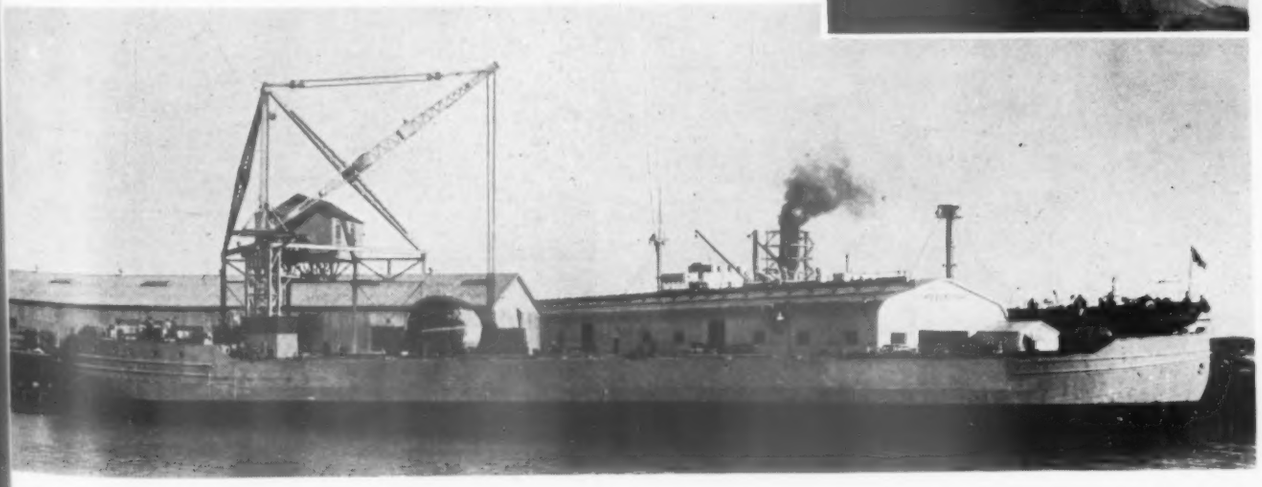
• (Below) All-welded workboat, 38 ft. long, with 10-ft. 3-in. beam and draft of 4 ft., built by Hans Hansen Welding Co., Toledo, Ohio, for their own use.



• Welded construction adds strength and rigidity to this all-welded screening machine for sizing and grading rock and gravel, built by the Consolidated Steel Corp., of Los Angeles.

• (Below) Welding a kitchen sink made of Enduro stainless steel.

• (Below) All-welded tanker "Transoil" launched by The Ingalls Iron Works Co. and described on page 42 of last month's issue.



The Power and Magic of Calcium Carbide in Industry Today

By B. F. KUHL
Shawinigan Products Corp.

DO YOU remember when you attended the theatre and for the very first time in your life saw a magician? From an empty hat he pulled a large and miscellaneous assortment of things ranging from bits of colored silk to the proverbial rabbit. How you thrilled! How you marvelled at the magic of this feat! On the stage, such acts of legerdemain are always a wow, even though we know them to be illusions. Our commercial wizards place in suitable equipment bits of lime and coal, waft the wand of electricity and draw forth silks, flavors, medicines, phonograph records and a multitude of other products. These are no illusions. These are practical results reaching heights no magician can ever hope to scale.

Researchers Seeking Aluminum Produce Calcium Carbide

But—we are a bit ahead of our story! Let's go back to 44 years ago when, on May 2, 1892, Thomas L. Willson and J. Turner Morehead, after spending many weary months on an experiment having to do with the production of aluminum, gave the world something entirely new—the first practical process for making calcium carbide in commercial quantities. The subsequent development of this process to its present high state of efficiency enabled chemists and outstanding industrial leaders to produce an ever-increasing list of goods that daily affect our lives, ease our burdens, and add immeasurably to our physical comforts and pleasures.

No wonder, then, that we who are affiliated with the great carbide and acetylene industry unhesitatingly and with some reverence, place the names of Willson and Morehead at the top of a long list comprising this branch in the chemical hall of fame.

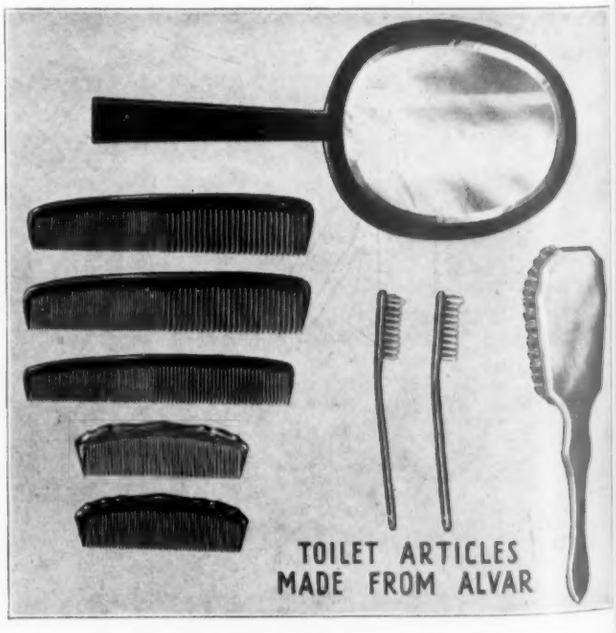
During 1890 Willson was engaged in improving electric furnaces, and processes for the reduction of metals. With a view to developing a number of patents he had taken out in connection with this work, he made arrangements with Morehead to erect a plant at Spray, N. C. Together they proceeded to try out Willson's idea for the production of aluminum. This was attempted with the use of carbon and aluminum oxide—but failed. Reasoning that they could obtain better results with the use of metallic calcium, a stronger reducing agent than carbon, they made an attempt to produce the calcium by smelting a mixture of coal tar and lime in their electric furnace. This mixture did not produce metallic calcium. It yielded calcium carbide.

Calcium carbide is a crystalline body, hard, brittle and varying in color from a grayish black to a dull brick red. If crushed while hot, it sometimes shows a bluish purple iridescence and the crystals have a tendency to be quite large. It is non-inflammable, infusible, non-explosive and unaffected by jars or concussion; or by time. If kept entirely dry and not subjected to contact with air, it is an inert and stable body.

One of the first uses of carbide and probably the most universally known is in the production of acetylene gas by means of house-lighting and welding generators. These are of two distinct types. As the names imply, the house lighting generator is designed to produce acetylene under low pressure for the lighting of homes and for cooking purposes. The type known as the welding generator is principally employed in the autogenous welding and oxy-acetylene cutting fields. These generators were first constructed so that water would drip on pieces of crushed carbide and decompose it with the subsequent evolution of acetylene gas. This process might be termed dry generation and is conducive to producing excessive heat. Under certain conditions and beyond certain limits excessive heat is detrimental in the practical application of the acetylene gas.

Wet Method of Making Acetylene Avoids Excess Heat

The next step was to overcome this difficulty. When it was learned that carbide could be "water jacketed" through feeding from a hopper into a tank of water—in the proportion of 1 lb. of carbide to one gallon of clean, fresh water (thereby dissipating most of this excessive generating heat)—an entirely new type of generator was born. So today the wet method of generation is used almost exclusively for general commercial purposes and practically all acetylene generators are so constructed.



Derived From Coal and Lime!

(From calcium carbide to acetylene gas to acetaldehyde to vinyl acetate to gelva to alvar — runs the life history of these articles!)

Testing Gelva Lacquers.

In the use of carbide with miners' caps and hand-lamps, and by railroad and highway construction gangs, where a very low speed of generation is required and where compactness and minimum weight of the lamps are a necessary requirement, the water-to-carbide—or dry generating method—is still followed.

Another direct use of calcium carbide is in the production of cyanamide; and cyanamide in turn becomes an agent for the production of an increasingly large list of chemicals.

Using lime (calcium) with coke (carbon) and the electric furnace as the smelting agency, we have all the elements for producing calcium carbide (CaC_2)—the base for a chemical tree whose first and principal fruit is acetylene gas (C_2H_2). Acetylene combined chemically with water produces acetaldehyde. This product combined with oxygen yields acetic acid. These might properly be termed the tree trunk from which the branches sprout in every direction—with smaller, though no less important, branches growing "every which way."

Pure Acetylene Gas Entirely Harmless to Humans

Acetylene gas is colorless and tasteless. In its pure state it has a sweet ethereal odor. But in commercial form it carries a slightly pungent odor due to small percentages of phosphoreted and sulphureted hydrogen. In its pure state it is without toxic or physiological effect and may be inhaled or swallowed with impunity. It has been used as an anaesthetic.

Acetylene possesses a higher candle power and flame temperature than any other commercial gas so far known. It will liquefy under a pressure of approximately 700 to 750 lb. to the sq. in. at 70 degrees F. The pressure necessary for liquefaction varies with the temperature up to 98°, beyond which it is impossible to liquefy at any pressure. Because of its endothermic energy, unabsorbed acetylene will explode of itself if ignited at a pressure somewhat in excess of 15 lb. per sq. in. The dangers inherent in the transportation of most gases, are removed in the case of acetylene by absorbing the gas in acetone. This, in turn, is absorbed by the cylinder fillers, consisting of some porous material such as cement, charcoal, asbestos, balsa wood or similar substances.

Acetylene gas with the application of steam is a direct step in the production of acetone. Acetone in turn becomes the absorbing agent for acetylene under pressure—reference, the acetylene cylinder of today. The production of acetone from acetylene is mentioned merely to show it can be done, but it is not being employed to any extent commercially, because of less expensive production methods now in use.

Pure Carbon Obtained Directly From Acetylene Gas

Again—working directly from acetylene—the gas is thermally and quantitatively decomposed into carbon and hydrogen, the carbon being in a particularly pure form, and we have a chemical product known as acetylene black. Some of its properties are a close approach to graphite; namely, high absorption qualities (one gram will absorb 20 grams of water and still yield a stiff paste), and the ability for high electrical conductivity. Acetylene black's principal use up to this time has been in the dry-cell industry. Due to its high electrical conductivity and liquid absorption qualities it is replacing wholly, or in part, the graphite in dry batteries. The high absorption quality enables it to hold more electrolyte and thus increases the capacity of the cell.

Acetylene black has been successfully utilized as a component of rubber in high grade automobile tires; as a pigment in paints and varnishes; and with fillers for acetylene cylinders. It is also used to some extent in the field of explosives. A cartridge is loaded with black and into it is poured some liquid oxygen which forms an explosive more powerful than ordinary powder, or dynamite. Its use for such purposes is limited because the cartridges have to be prepared more or less locally at the point of use, and must be used within certain time limits, because the evaporation of the oxygen affects the explosive strength.

Acetylene gas combined chemically with water yields acetaldehyde, and acetaldehyde combined with oxygen will produce acetic acid, as has been stated before. Through various processes and stages, using acetaldehyde as the base, aldol, crotonaldehyde, butyraldehyde, butyric acid and the butyl esters are formed. These last named, butyl esters, enter into the production of flavors, perfumes, etc.

Originally acetic acid was produced by the destructive distillation of hard wood along with wood alcohol and charcoal. Since the process of production from acetylene was originated and developed, rapid progress has been made. At the present time approximately two-thirds of the acetic acid consumption in this country is supplied with synthetic acid; greatly reducing prices and thus permitting the use of acetic acid for many new purposes. Most important of these is the manufacture of cellulose acetate silk. The romantic development of limestone and coal to ladies' silk stockings, bathing suits, underwear, curtains, etc is a bit of up-to-date magic that cannot be improved on.

Acetic Acid Field Uses Over 200 Tons of Carbide Daily

To anyone at all familiar with the production of dissolved acetylene it may be of interest to know that considerably in excess of 200 tons of carbide per day is utilized in the production of acetic acid on this continent alone. This will give some idea of the magnitude of this industry.

Acetaldehyde, if reacted under proper conditions with acetic acid, will form vinyl acetate. Vinyl acetate is a double-bond compound which polymerizes readily to form a series of vinyl acetate resins, such as our gelvas, alvars and formvars, the uses of which are still somewhat in the development stages.

Gelva possesses, as one of its outstanding characteristics, a remarkable power of adhesion to porous and nonporous surfaces. The strength of the bond on a straight pull, where various

More Uses for Acetylene Gas!

(Alvar, aforementioned, can be molded into any shape, these being but a few of the forms it has been pressed into.)

Calcium Carbide Gum!
(Let the chicle industry beware. It may be gassed by acetylene.)

polished metals and glass were bonded without pressure, has been found to be over a ton per sq. in. Bonds have actually been made so strong that conchoidal pieces were pulled out of plate glass without breaking the bond to a metal plug. This extraordinary power of adhesion has made gelva a useful adhesive in assembling safety glass laminations.

Gelva Has Uses Ranging From Paint to Chewing Gum

Gelva is also an excellent vehicle for aluminum, copper and bronze pigments, because it does not cause them to discolor on standing. Its freedom from color and absence of discoloration in sunlight gives a much truer metallic color than is possible with the usual vehicles. It is very satisfactory in use as a priming coat on metals; in the production of lacquers, and as an impregnating agent for light-weight paper to increase its strength and to render it transparent, grease-proof and water resistant. Gelva may be dispersed in the form of a stable emulsion capable of almost infinite dilution, and in this form offers interesting possibilities for the impregnation of textiles in the manufacture of uncrushable velvets, starchless linens and curtains, fused type collars, etc. It has been successfully used in the bonding of leather, felt, cambric, wood, porcelain, metals, plastics, cellophane, kodapak, sylphrap, plyofilm, metallic foils, mica, stone, etc.

Among some of its very out-of-the-ordinary uses has been its substitution for chicle in the production of an excellent chewing gum.

Formvar is a product of gelva, in which a percentage of acetates have been replaced with formaldehyde. Its uses are still in an experimental stage of development.

Alvar, Product of Gelva, Works Up Into Moulded Articles

Alvar is similar, except that a percentage of the acetate groups in gelva has been replaced with acetaldehyde. Alvar gives a more viscous solution, has a higher softening temperature, and is harder and tougher than the gelva from which it is made. It is employed largely in thermo-plastic molding, with a wide range of possibilities in that field. Articles so produced possess great mechanical strength and flexibility, high dielectric strength and a hard surface which is unaffected by aging, or direct sunlight. Buttons, poker chips, fountain-pen tubes, combs, toilet articles, bracelets, screw tops for bottles, panels for radio cabinets, transcription records for use in radio broadcasts, fancy boxes and novelties of all kinds, comprise a partial list of articles so far produced.

Note some of the startling peculiarities born at various stages during the development processes and the rearing of these calcium carbide children. In the manufacturing plant, repair shop, and so on the value of acetylene in a large measure depends greatly on its being kept under control when in compressed form in cylinders. The acetylene cylinder is very essential as a mode for transportation and providing the portability so necessary in a great number of instances where apparatus must be moved from point to point, also where it is not possible to pipe acetylene from a generator to the point of consumption.

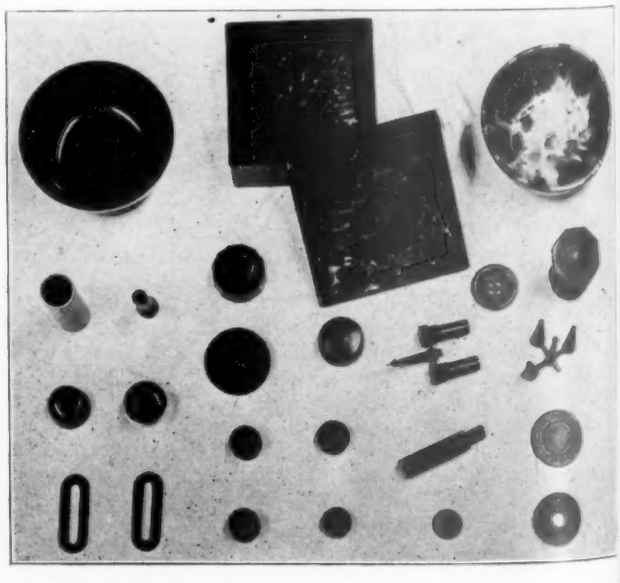
To promote these safety factors, and to permit the loading of the cylinders with the maximum amount of acetylene possible under pressure, at the same time avoiding liquefaction, under certain conditions, it is necessary to harness the acetylene by means of an absorbing agent—in this case, acetone. Acetone, first obtained from acetylene, in turn becomes the medium of control for the very substance responsible for its own existence. We have here the strange case of the derivative making it possible to control and utilize, under a fixed condition, its progenitor.

From acetaldehyde is obtained acetic acid, and once more we use a derivative to work on its immediate originating substance, when acetic acid is reacted with acetaldehyde to produce vinyl acetate.

Take Acetylene From Carbide—Excellent Lime Left!

After yielding up its acetylene gas, calcium carbide, through its residue, still possesses many useful qualities. Carbide residue is really a very good grade of hydrated lime of exceptional fineness which makes an excellent whitewash for indoor and outdoor application—is valuable, inexpensive and efficient as a substitute for the lime content in mortar mixtures, plaster, stucco and concrete. It has been approved and permitted in the building codes of some of our larger cities for these purposes. It is being used successfully in spraying solutions, insecticides, disinfectants, in the correction of soil acidity and as a preservative for fence posts, etc. Also it is being used for cleaning and polishing bright metal parts on machinery, household ranges, water faucets, tinware, glassware, etc., etc.

It is rather sad to relate that the virtues and possibilities of carbide residue—or "carbide sludge," as it is commonly called—are not fully appreciated, and



Buttons & Bottle Stoppers.
(Also poker chips, ash trays and a dozen other articles, all descended from calcium carbide.)

Acetylene Goes on the Air.
(And it also gets walked on. Radio broadcast records and heels for women's shoes are among the alvar products born of calcium carbide.)

it is usually thrown away by the operators and owners of generators when cleaning or recharging the machines. Carbide manufacturers can readily supply detailed information to aid in its utilization and to increase its value.

All this has been made possible with calcium carbide. Today the oxyacetylene industry of which carbide is a basic part, ranks eighth in the capital structures of domestic industries. It still grows and grows.

Carbide a Product of Great Potential Power

Have we appreciated the potential power contained in that bit of limestone; that bit of coal or coke, plus the electric energy which has given us calcium carbide? Nothing colorful to look at, is carbide. In fact it is a very drab-looking, inert material. And yet it is the principal ingredient in the crucible from which our wizards and dreamers—chemists, scientists and engineers—withdraw so abundantly many blessings touching our every-day lives. From an instrument of construction and destruction, to the delicate heights of perfumes and medicines, acetylene from calcium carbide plays its part, and does it exceedingly well.

Having had the privilege of being associated with this industry for 17 years, the period covering the most rapid part of the developments cited, my hope is to continue and see still more startling results. Unquestionably the surfaces have hardly been scratched.

There has been much romance and magic in our industry in the past, and much more is still in the future. Who knows whence will appear another Willson, another Morehead, to add still further to the glory of achievement through the mediums springing from two natural materials—limestone and coal electrically combined—which is calcium carbide?

American Soc. for Metals Holds Two-Day Meet

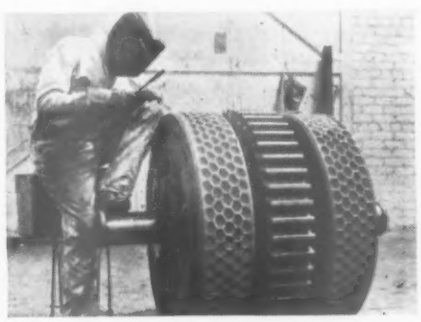
The Pittsburgh chapter of the American Society for Metals in conjunction with other chapters from Pennsylvania and New York, held a two-day conference at the Pennsylvania State College, State College, Pa., May 1 and 2. The School of Mineral Industries, of which Dean Edward Steidle is the head, acted as host.

Among the speakers were Edgar C. Bain, assistant vice president of the United States Steel Corp., who is also vice president of the society, and V. N. Krivobok of Carnegie-Illinois Steel Corp., Pittsburgh.

Large Wheel Form Press Is Built Up by Welding

The building up of the worn edges of a large wheel form press used in the manufacture of "briquettes," a domestic heating commodity used in southern California, is shown in the accompanying photograph. The work is being done by electric process, the cup-shaped edges being built up to the required height and to conform with the necessary contour of the form.

This job saved the owners several hundred dollars, as otherwise an entirely new press unit would have had to be purchased. After welding up the edges, the entire wheel surface was machined smooth, and a special machine cut the inner surface of each cup to its required depth. This job was handled recently in a Los Angeles job welding shop.



Price of New Press Saved.
(Worn edges of cup-like depressions were built up by arc welding, after which the surface was machined.)

I. C. C. Grants Construction of Fusion-Welded Tanks

Authority to construct a certain number of tank-car tanks for certain specified purposes, by the fusion-welding process, has been granted by the Interstate Commerce Commission to several petitioners, according to the *Compressed Gas Bulletin*, of the Compressed Gas Manufacturers Association. The decision, dated Apr. 15, pertains to 15 tank-car tanks to be constructed for experimental service, by the Union Tank Car Co., and grants the same company privilege to use in experimental service 10 tank-car tanks already constructed; also one tank-car tank of nitric-acid-resistant metal, for experimental service, by E. I. du Pont de Nemours & Co.; and tank cars not exceeding 25 in number, for experimental service, by the Phillips Petroleum Company.

In the cases of the Union Tank Car Co. and the duPont company, the decision is a result of a reconsideration of the applications of these firms, whose petitions for the construction of tanks by fusion welding were denied by the Commission in a previous decision dated Nov. 13, 1935.

Railroad Starts Construction of Welded Rolling Stock

A large program in the construction of welded passenger and freight cars is being undertaken by the Chicago, Milwaukee, St. Paul & Pacific Railroad at its Milwaukee shops. The construction, in which a great deal of low-alloy, high-strength steel will be used, entails 37 passenger cars, comprising six different types, and 1,500 freight cars, consisting of 500 coal gondolas and 1,000 automobile cars. The program, which also includes a new stream-lined steam passenger locomotive, to be built by the American Locomotive Co., involves an expenditure of $4,800,000 and is expected to furnish work to 850 men for eleven months.

While an uncovered 6-in. flange in a steam line wastes from 1 to 2 tons of coal a year, it is considered good practice to leave the flanges bare and permit the waste to continue, because of the expense of removing and replacing insulation when bolts have to be drawn or gaskets replaced. In a welded steam line such waste is eliminated, because joints never leak and can be permanently insulated.

Design and Construction of

Gears and Gear Cases Employing Cast and Rolled Steel Assembled by Welding . . .

Paper presented before the annual meeting of American Gear Manufacturers' Association, Philadelphia, Pa., April 21, 1936.

By EVERETT CHAPMAN,
Vice President, Lukenweld, Inc.

Fig. 2. Photoelastic Specimen Illustrating Concentrations of Stresses in a Double Fillet Weld.

(The thicker section can be considered as representing the rim of a gear, and the thinner section as representing the web. By welding completely through the web, the crack would be eliminated, and the unit stresses would be made uniform.)

ROLLED steel plate, in conjunction with steel castings, is the most equitable combination of materials for the designer. Steel, of course, is the most rigid material available, and nothing can be gained by consideration of other materials of construction from the standpoint of rigidity. The creation of a suitable stiff construction lies entirely in the ability of the designer to apportion and distribute his various sections.

With alloy steels, the modulus of elasticity is the same as that of the mild steels, and the stresses for adequate rigidity are generally so low that the superior yield point of the alloy steels means nothing.

The proper steels for welding are those with a very low carbon content. To be more general, the proper steels are those in which the alloy content, including carbon, is such that the air-hardening properties are minimized. This fact is of importance from two standpoints: first of all, metallurgical damage is very severe in the more hardenable steels when they are welded, which generally shows up as shop trouble in the form of cracks; and second, the hardened zones constitute a nuisance when later the case is machined and the planing or milling tool constantly encounters hard areas.

Fig. 1. Butted Joint Welded on Only One Side.

(High concentration of stresses occurs at the unfused root of the weld, and the discontinuity may readily be propagated through the weld in the form of a crack.)

In welding, the steel is subjected to extreme temperature gradients, not only by the welding process itself, but also by the flame-cutting process. When either cutting or welding steel, a localized area of very high temperature is created. The cold body of the parent metal then acts as a heat sink and the zones adjacent to the region of high temperature are severely quenched.

Welded structures should be heat-treated afterward to eliminate even the slightly damaged zones, and to reduce

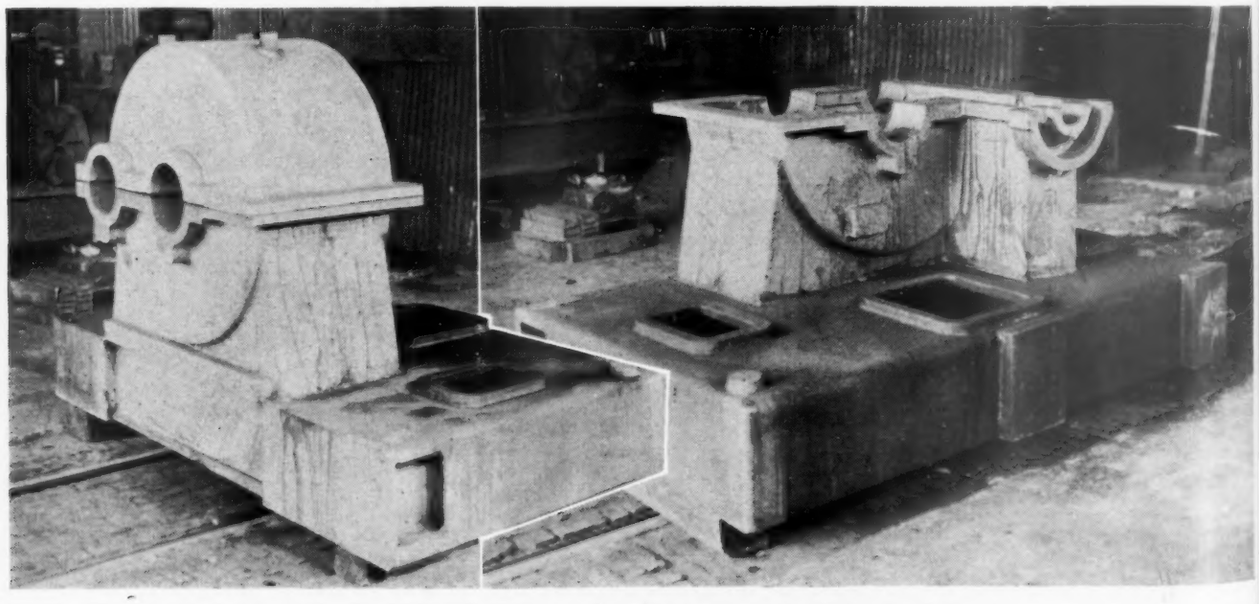


Fig. 3. Single-Reduction Unit Built Integral With the Oil Pan.

(In this design torsional stiffness has been considered. The case is made of two spun tank heads of steel plate, inside of which is a second semi-spherical plate which supports the bearing on two points. The bearings themselves are made of cast steel, since there are oil-return passages involved. The view on the right shows the pinion bearing as a casting supported by bent plate box sections.)

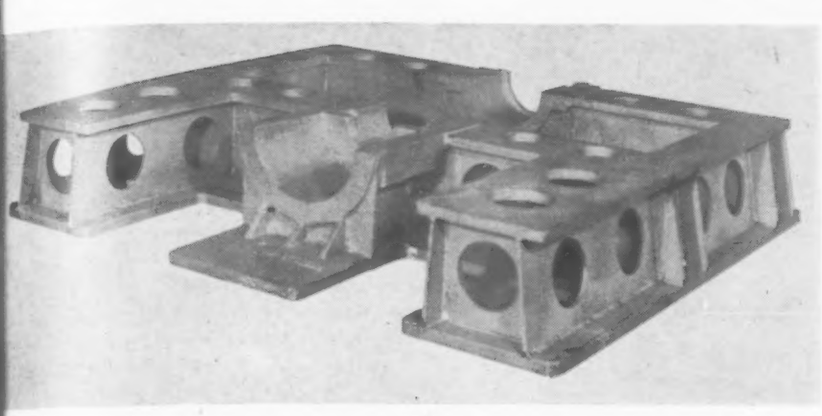


Fig. 4. Lower Half of Single-Reduction Turbine Marine Unit.

(The thrust block is a steel casting with welded plate assemblies attached to the adjacent sections. This thrust block was cast because the requirements of the enclosed Kingsbury bearing were such that the slipper pads thrust against very heavy shoulders. The casting was the more economical way to produce this part. Making solid, sound welds in 2- and 3-in. sections is feasible but costly where the parts are light.)

to an utter minimum the locked-up residual stresses which are always present. A prolonged soak at 1200° F. is satisfactory. At this temperature, steel has a yield point in the neighborhood of 4000 lb. per sq. in.; and hence at 1200° F. given a proper time for soaking, the residual stresses in the structure will be of the order of magnitude of 4000 lb. per sq. in. Stresses of this order when relieved by machining do not distort the structure to a measurable extent. While 1200° F. is not a re-crystallizing temperature, it is a tempering temperature for the hardened constituents usually found in steel.

Another point of importance in the heat treatment of welded structures is the length of time necessary to thoroughly stress-relieve. The usual metallurgical criterion is one hour per inch of maximum thickness. This is not sufficient for stress-relief. One hour per inch of thickness is the time necessary to raise the interior of a piece up to the desired temperature to produce the required metallurgical phase changes.

However, the phenomenon of stress relief is that of allowing the steel to "creep" (like tar) at elevated temperatures, and this is a function of the length of time at the stress-relieving temperature. It is necessary, for adequate stress-relief, to increase the time that the piece is in the furnace at 1200° F. Pieces should be allowed to furnace cool to at least 250° F. and should be so protected in the furnace that differential temperature gradients are not produced as the piece is being heated up.

Another point to be considered in choice of steels for welded structures is that of cleanliness. The characteristic of a "killed" steel is that segregation, such as occurs in the "rimming" steels, is minimized. The residual impurities are distributed throughout the main body of the ingot as finely divided particles. Its properties in all directions are substantially the same, while the "rimming" steels have marked differences in properties, depending on the directions considered. "Killed" steel is the most suitable material for welded structures that are to be extensively machined.

Most gear-case designs benefit by the inclusion of castings in parts of the design where complexity legislates against a sound welding job. A bearing with complicated oil labyrinths and multiple shoulders as a casting is decidedly satisfactory. Low-carbon, electric-furnace castings are thoroughly weldable and no trouble will be experienced in their use.

Castings for Welded Structures Should Have Low Carbon Content

The main precaution in the use of castings in a welded structure is to keep the carbon below 0.20%, and preferably around 0.15%. True enough, steels of higher carbon content can be welded, but the utmost ease of fabrication and therefore the highest predictability is accomplished when the carbon is set at the limit that has been specified.

The foundry prefers a higher carbon content because the steel runs easier, but this should be sacrificed to the requirements of the welding operation. The quenching action of thick sections is as important in castings as it is in rolled plate, and the non-weldability of certain castings hinges on this point.

The only other precaution, outside of the limitation of carbon content, is that the joints to be welded should be thoroughly cleaned down to bright metal. Foundry sand may be found embedded

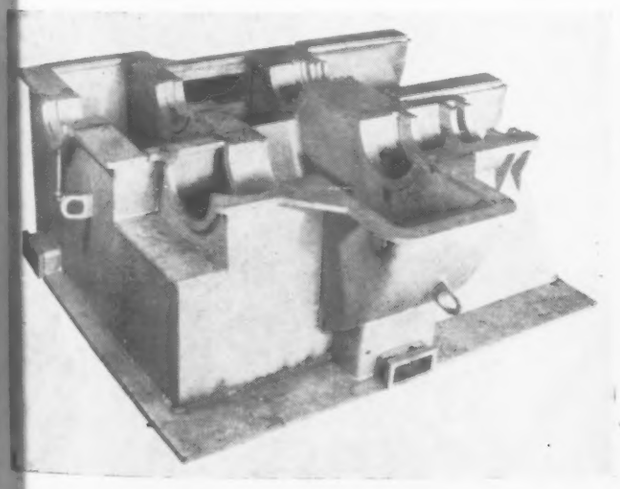


Fig. 5. Welded Assembly of Pressed and Spun Shapes and Castings to Form a Gear Case of Great Rigidity.

(This gear case, another view of which is shown on the cover of this issue, mounts the turbine, the first reduction, the large bull gear and a hydraulic coupling, all of which are coupled in parallel with an existing reciprocating-engine, installation. This unit has been at sea for several years and the performance has been satisfactory. A structure of this magnitude must be thoroughly annealed, else in machining it will creep, warp and squirm like a live thing. What is more important, it may creep out of line in service, even if the manufacturer is sufficiently capable to master it during the machining operation.)

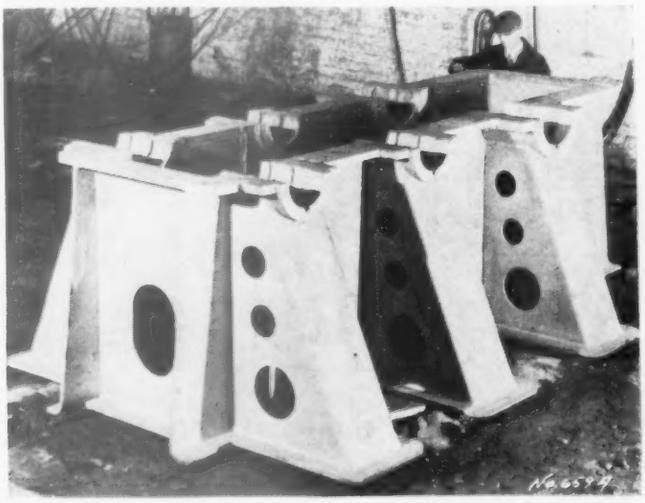


Fig. 6. Double-Reduction Gear Used in Dredging Service.

(This is a component structure consisting of cast bearings and rolled stock bent to form. The lightening holes in the sides of the bent pieces are not so much to reduce weight as they are to furnish accessibility to the back side of what otherwise might be one-sided welds. While it is true that the working stresses in a gear case must be of a low order of magnitude in order to produce the requisite rigidity, it does not take much of a vibrating or recurring load to propagate a crack through a weld which starts at an unfused root. The type of cracks which exist around welded joints is most severe.)

Fig. 7. Pinion Stand Made From Plates With Cast End Bearings.
(The sections required for the support of the bearing were so thick that it was uneconomical to cut them out of a plate. It is perfectly feasible to cut bearing blocks out of thick plates up to 20 in., but the use of a gas torch on this gauge of material is rather expensive, and even more pertinent is the fact that 20-in. slabs are not easily available for the purpose of cutting out a small bearing.)

in the surface of the casting, and foundry sand is a fertile source of porosity in the finished weld.

Harder Steels on Rims Reduce Wear of Gear Teeth

A third type of material that is useful in a welded gear-reduction unit is those somewhat harder steels employed in the rims of the gears to reduce wear. It is debatable whether the hardness of the rim as it affects wear resistance should be subordinated to uniformity as it affects uniform machining which in turn promotes accurate tooth profile. However, in those cases where a medium wear-resisting steel is desired, our company has used 0.30% carbon steel with a manganese content of around 1.30%, having a Brinell hardness of 160. This is a tough steel. It has been supplied, in several installations, and our experience is that this steel is at least worth the trouble which it entails.

The welding of such a steel, which will be recognized as extremely air-hardenable, is accompanied by a great deal of hazard, especially in gears. The trouble is due to this: A gear rim or a band of steel is extremely rigid under the action of a system of radial tensile forces. Radial tensile forces are exactly what the contracting weld metal sets up when the web is welded to the rim. The rim, being extremely rigid under this loading, cannot deform and the result is that welding a web into a rim is a hazardous procedure. Many cracks can occur during the process. The procedure which seems to prevent the most trouble in welding such a steel is to have the rim and the adjacent steel quite hot, preferably around 300° F. and, what is more important, to remove all root rips before they can occur.

Poorly Executed Welds Produce Built-In Cracks

This brings up a second important point in the design of welded joints. Unless properly executed, a welded joint presents one of the most abrupt changes of contour ever created. Properly done, it is one of the best. The seat of this lies in the fact that poor execution in the design and fabrication of the joint results in built-in cracks whose mathe-

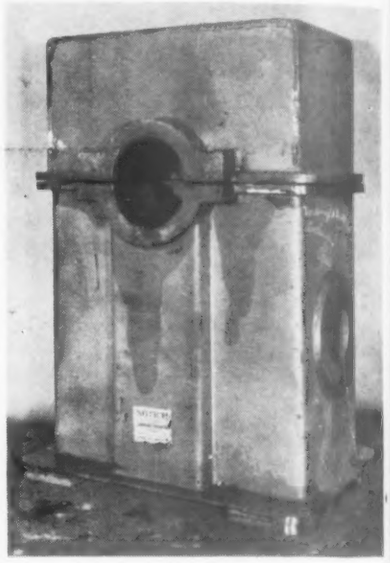


Fig. 8. Worm-Reducer Housing With Single Walls.
(The frame is strengthened with ribs, which are on the inside of the case and transmit their rigidity to the foundation. The bearings are supported by a bent section which goes directly to the foundation.)

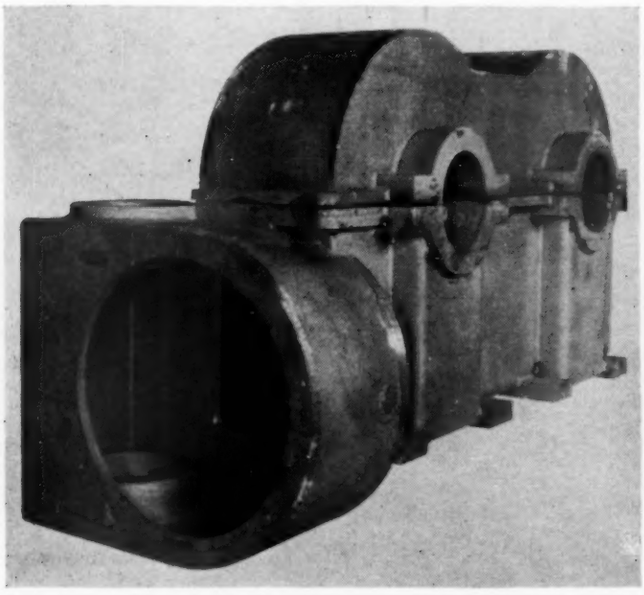


Fig. 9. A Welded Case of This Type Is Much Lighter Than an Equivalent Casting.
(The intricacies of the various contours would call for much greater wall thickness in a cast product. This is a double worm reduction with a vertical worm on the first reduction.)

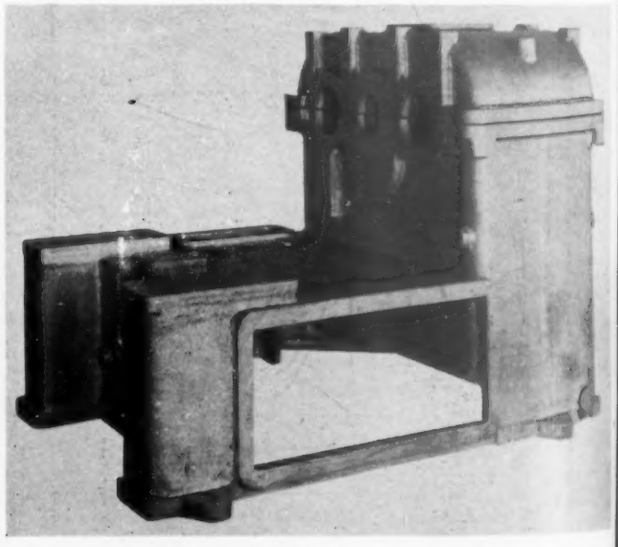


Fig. 10. Turbine Gear-Reduction Unit With Centrally Bolted, Singly Supported Bearing.
(The bolting bosses run completely through the top of the case so that the bolts can be kept on the center line of the bearing itself. This is a possible construction, although in general it will be found rather expensive. In the design shown, the mount for the turbine is built integral with the gear case.)

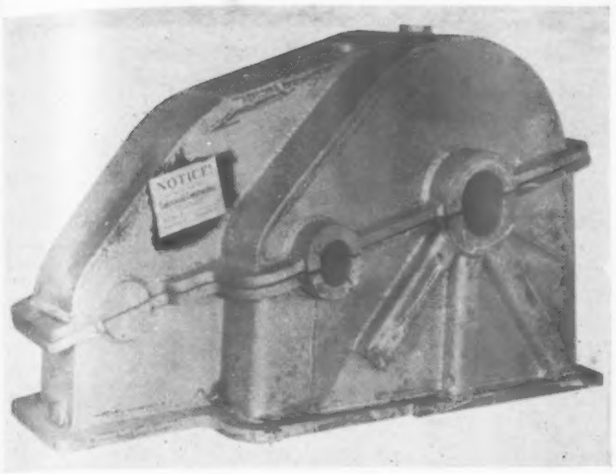


Fig. 11. A Gear Case of Very Light Construction.

(This is typical of the sections that can be easily produced in welded steel. This type of gear case has found a wide use in marine auxiliaries.)

matical exactness far supersedes anything that one could produce by any other means.

An elementary and quite common case of a poorly conceived welded joint is shown in Fig. 1. One must think of a finished welded joint not as three pieces of metal, but as one piece of metal. The distinguishing point is that the modulus of elasticity is exactly the same from point to point and therefore the stress distribution is determined only by the resultant contour. Fig. 1 shows what results when two plates are butted together with a small bevel on one side and weld metal is deposited in the groove. The fusion is perfect, as far as it has gone, and the weld metal is perfect, but there remains the unfused root. This unfused root is not the junction between two pieces of steel but is a severe mathematically sharp crack in one continuous piece of steel. The stress concentration produced by such a contour is high in magnitude. The local stresses at the root are ten times the average stress, and the contracting cooling weld metal on either side of this joint may serve to propagate this rip through the weld which has just been deposited. In service, a vibrating load or a constantly recurring load may easily propagate a fatigue crack out through the weld.

A double fillet weld can be just as bad under certain conditions of loading. The stress concentration, due to the resultant internal crack, is extremely severe. Fig. 2 shows, photoelastically, the distribution of stress around such a contour. The bakelite specimen has been cut to simulate the contours of a double fillet weld. The load has been axially applied. The weld looks perfect from the outside, but there is a crack on the inside where the welds did not meet.

Consider the thicker piece of metal as the rim of a gear, and the thinner piece as representing the web. Due to the contracting weld metal of the fillet, and the symmetrical distribution in a circle, the system of stresses which are created load the weld as shown in this photograph. As the weld is completed, the stresses become greater and greater. The stress multiplies at the root. The parent metal has been damaged because of its analysis: 0.30% carbon and 1.40% manganese. It is exceptional that such a configuration can be welded cold in the shop.

Keeping Piece Hot While Welding Slows Quenching Action

The solution is to keep the piece hot throughout the welding operation to slow down the quenching action of the cold parent metal. The resultant stress becomes more of a compressive stress when the piece cools off. The other major precaution is to remove the root crack on the inside of the two fillets by welding completely through from one side, chipping out the far side, and completing the weld. Around such a solid piece of metal there can exist no stress concentration.

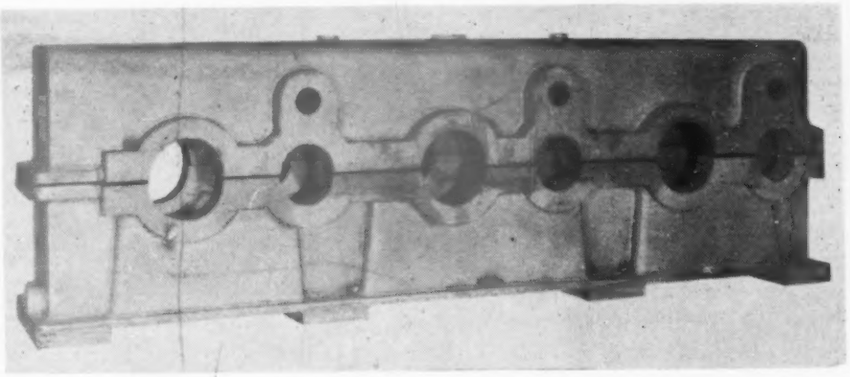


Fig. 12. A Long, Narrow Gear Case Like the One Shown Presents Problems of Torsional Stiffness.

(Either half of the case in itself constitutes a rather flimsy torsional member, and it is necessary that the top and bottom half be united by fitted bolts in order that adequate shear transmision might be effected.)

Let us consider the sum of two of these effects occurring at the same place. The stress concentration at the root invariably occurs where the weld stops, and the metallurgical damage to the parent metal occurs at the same place. The metal at this point is in no condition to deform plastically to rearrange the stresses, and at exactly this point the stresses are multiplied tremendously by the presence of the unfused root. Where ductility is mostly needed, there is none.

The design aspect of gear units is paramount and separate from the method of fabrication. The prime requisite of the design of a gear reduction unit is to produce sufficient rigidity to maintain uniform tooth contact. The prevention of objectionable noises is another design objective. The required rigidity in a gear case is gen-

Fig. 13. Combined Bed and Gear Drive for a Flying Shear.

(In this construction, weight was no object, and the bearing supports are simply formed from thick flame-cut slabs with sufficient bosses on the outside to produce the required length of bearing seat. Such a construction is very rigid and has been found to be quite economical in welded steel construction.)

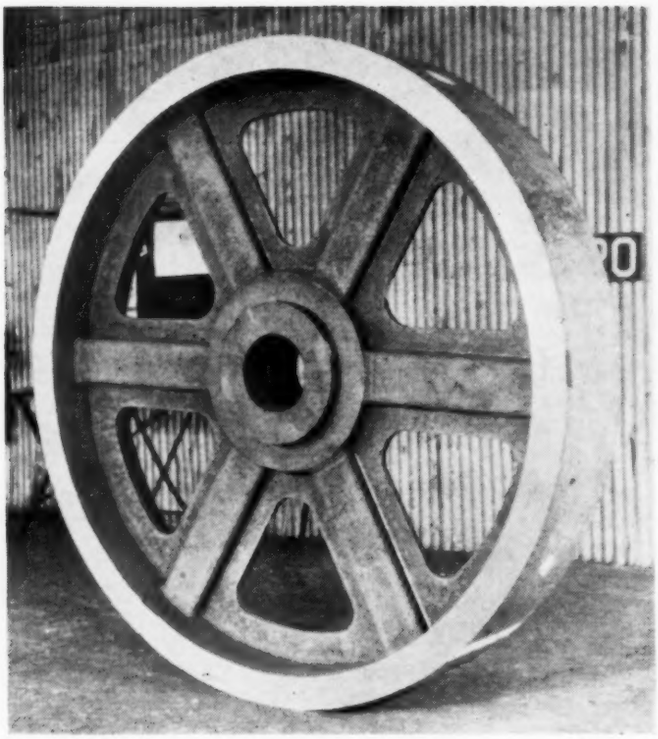


Fig. 14. Large Blank Gear for Punch-Press Drive.

(The rim is formed of a rolled steel member, and the web is fitted and reinforced with hollow bent box sections.)

erally of two types: an overall torsional rigidity, and sufficient local rigidity underneath the bearing seats to prevent deflections of the shaft.

In the creation of torsional rigidity, care must be taken to use closed sections. In general, since gear cases are split through the center lines of the shafts, preservation of the torsional characteristics of the resulting open boxes hinges on the liberal use of fitted bolts in the flanges. If bearing caps are used with a light cover, they should be doweled in sufficiently well to produce the shear transmission necessary for torsional stiffness. Figs. 3 to 13 illustrate gear cases employing various designs and constructions, fitted to meet the particular needs of each case.

Single Bearing Often Should Have More Than One Wall Support

Most of the constructions illustrated are of the double-walled type, or the bearings themselves are supported by a double wall which in turn goes to the foundation. It is held essential that more than one wall should support a single bearing. Ribs in general look feasible and may afford a presentable appearance, but the only function that a rib can possibly perform—unless it goes to the foundation—is to transfer the bending moment from the piece which it supports to a point where it vanishes into the supporting plate. As such they are rather a delusion. This point is brought out by the design shown in Fig. 9.

Fig. 14 shows a large gear for a punch-press drive, in which the rim is formed of a rolled member. A web is fitted which is reinforced by the hollow bent box sections.

Weld Metal in the Joint Should Be Below Pitch Line of Teeth

It has been found necessary to keep the weld metal in the joint below the pitch line of the teeth. Weld metal, as deposited in a properly protected arc, is a very soft, ductile material and does not possess a high degree of wear resistance. Neither will it withstand the rolling, peening action of engaging teeth as well as does the 0.30%-carbon, 1.40%-manganese steel which has been suggested.

In making these rims, therefore, the rim is bevelled from the inside to a point which comes just above the root

Fig. 15. Welded Joint in Gear Rim.

(The weld metal is kept below the pitch line of the teeth since it is a softer and more ductile material than the metal of the rim itself.)

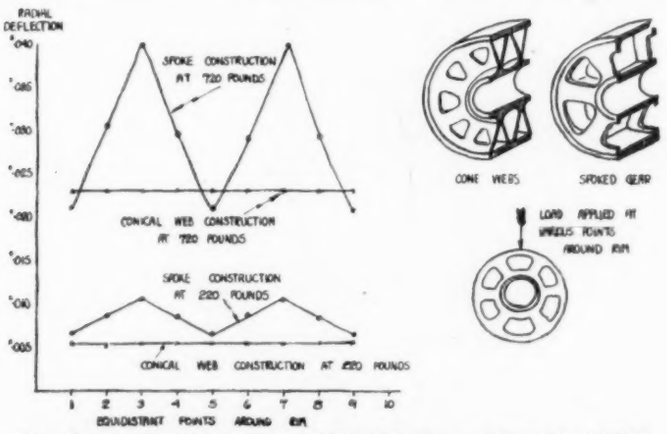


Fig. 16. Deflection Curves of Spoked Gear and Conical-Web Gear.

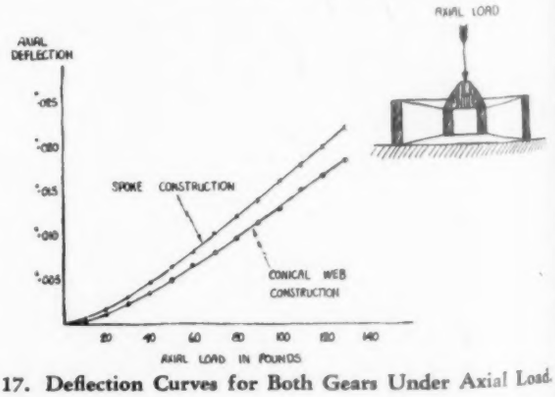


Fig. 17. Deflection Curves for Both Gears Under Axial Load.

of the teeth which will subsequently be cut. This bevel is then welded completely. The crack which exists on the outside due to the unfused root is left in the rim. This gives the manufacturer an index to the proper place to start cutting his first tooth. This procedure results in a complete homogeneity of the material in every tooth in the rim. Fig. 15 illustrates this method. This scheme has been extended to herringbone gears, requiring a double angle flame-cut.

Spokes Running Past Pinions May Cause Gear Noises

Prevention of noises in gear sets revolves about the following point: The whole body, or any part of it, has natural frequencies and may be excited at that natural frequency by a forcing frequency in tune with it. Forcing frequencies can come from many sources, and they must not find any sympathy at any point. An example of this occurred when a welded steel gear in a rubber mill drive was found to sing and vibrate rather badly. It was in a multiple train of gears. Further down the train was a gear with cast teeth. It was found that the frequency at which the welded steel gear vibrated was a multiple of the number of teeth on the cast gear. The web was located as the offending member. By cutting larger holes in the web the noise was completely stopped, since this raised the natural period of the vibrating portion of the web above the exciting frequency of the cast teeth.

Another source of noise in large gears is the effect caused by the spokes running past the pinion. A spoked gear has a disymmetrical rigidity from point to point on the rim. The varying deflections cause a rumble.

Gear Webs of Conical Shape Show Advantages

A new type of gear employing conical webs has homogeneous rigidity from point to point. As each point goes past the pinion, and is successively loaded by the pinion tooth pressure, the deflection of the rim is kept uniform. This is a large factor in the elimination of periodic groans.

Small steel models of both a spoked gear and a conical-web gear were made. They were supported at the hub and a load was applied at increments around the rim. Fig. 16 shows the type of gears employed, together with the deflection characteristics of the two types. The curves were taken for two loads — 221 and 720 lb. — and the resultant distortions of the rim in the disc and spider types were plotted as ordinates. The disc construction has a uniform deflection from point to point around the periphery, while the spider construction has a variation in deflection of some 100%.

When the webs are formed as cones, several other advantages accrue. In welding, the radial tensile stresses which are set up can do nothing but move the hub axially backwards and forwards. The structure is not stiff for this type of loading, especially when only one cone is in place. After the second cone is in place the structure of course is thoroughly tied, and its resistance to axial loads such as might occur in a helical gear is great.

Fig. 17 shows the elastic deflection characteristics under an axial load and affords a comparison between the spider and disc construction. For an equivalent amount of material, the disc construction has, roughly, 78% of the axial deflection of the spider construction.

The art of welding two pieces of steel into one is gradually becoming a science. The principals are well known. The greatest unexplored field today is the design possibilities that are inherent in this fabricating method. The possibilities are unlimited and the material is homogeneous.

Issues Specifications on Bridge Welding

"Specifications for Design, Construction, Alteration and Repair of Highway and Railway Bridges by Fusion Welding" is the title of the American Welding Society's first specification for bridge welding.

There has been, hitherto, an increasing use in the United States of the welding process in the construction of new and, more especially, the repair or strengthening of old bridges. This work has been very largely under the supervision of competent welding engineers and contractors definitely interested in the application and promotion of welding in bridge construction and repair. It may be anticipated that, with the issuance of standard specifications in this field, there will be a more widespread employment of the process.

The committee who drew up this specification accordingly feels that, while a specification cannot and should not be a textbook, it is highly desirable to supplement the mandatory clauses with informatory and cautionary material.

The personnel of this committee comprised men whose activities had been associated with welding in all of its diversified branches, including the construction of highway and railway bridges, and who represent the membership of various national engineering societies.

The further need of progressive research is clearly recognized, and, as an aid to that end, it is felt that this specification should be promptly put to the test of actual use.

The specification comprises 66 pages, 19 illustrations and is bound in a blue cover. Copies are available at $1.00 each from the American Welding Society, 33 West 39th St., New York, N. Y.

Flooded Areas Make Swift Come-Back

Business men of the nation have marveled at the rapid and remarkable comeback which the great industrial firms in the flood-devastated areas of Pittsburgh, Wheeling and Johnstown have made. Some idea of the immense havoc wrought by this major catastrophe came to light recently when Dun and Bradstreet released statistics, collected through their agency, which showed that the flood entailed losses upon 3,044 firms in the stricken area.

There was nothing left for the industrial giants in the Pittsburgh district to do but to say "the show must go on"; and today, throughout the flooded area, there are scarcely any signs whatever of the disastrous calamity which caused more than two hundred million dollars in property losses.

Practically all the large fabricators of welded equipment, and most of the smaller ones, have resumed normal factory operations. These include such large units as the various subsidiaries of the United States Steel Corp., Jones & Laughlin Steel Corp., Bethlehem Steel Corp., Dravo Contracting Co., Westinghouse Electric & Manufacturing Co., Wheeling Steel Corp., and the Treadwell Construction Co.

As a direct result of the flood, there has been an urgent demand for all types of materials and supplies, including welding equipment. The flood caused considerable damage to underground pipelines, sewers, conduit lines and other sub-surface structures, with the result that the glow of the welder's arc or torch was a common sight on the main traffic arteries and in industrial plants.

Manufacturers of electric equipment have had to meet an unprecedented demand for all types of materials, and the old maxim "every cloud has its silver lining," has come true so far as this great industrial center is concerned.

Welded Hulls for Boats at Elizabeth, Pa.

The Pittsburgh Coal Company has started repairs to the steamer Ranger at the company's marine ways at Elizabeth, Pa.

The repairs, which are confined chiefly to the operating machinery, also include an all-welded steel hull for this boat, which was delivered May 1. The repairs are to be completed about the first of August.

A welded steel hull is also being built for the steamer Cruiser of the same company.

DESIGN of WELDED STEEL STRUCTURES

Having COMPOSITE PROPERTIES . . .

Paper read before meeting of American Welding Society, Pittburgh, Pa., May 15, 1936.

By ROBERT E. KINKEAD
Consulting Engineer

ANY designer of machinery and equipment can design for welded steel construction, if he has a list of standard welds and information on the kind and amount of loading each will carry.

The design problems of saving money with welded steel are problems of cutting and forming available steel, rather than problems of welding. There are certainly not less than 400 machinery and equipment designers in the Pittsburgh and Youngstown districts who design in welded-steel construction with the same freedom that they design in castings.

Many of the heated arguments between advocates of steel castings and welded steel have been settled in the time-honored way. The proponents of welded steel are using more steel castings, and the steel-casting enthusiasts find themselves using more welded steel. Human nature seems to work thus.

"Means of Repair" Was Primary Concept of Welding

The primary conception of welding is that it is a method of repairing something that has been badly worn or broken.

A second conception is that of a means of manufacturing an assembly of metal parts into some useful product.

A third, and possibly the latest, conception of welding is that of building a continuous metal structure in which the metal at any location is of such physical properties as to just meet the service requirement at that point.

This last idea seems likely to do more things to our traditional methods of making and using steel than anything that has happened in metal-working in a long time.

For thirty years, the steel mills have been trying to make steel uniform in chemical analysis and physical properties. The new concept is likely to make these mills spend the next thirty years trying to keep from making steel uniform.

Let me illustrate this point by referring to bath tubs such as are found in a large modern hotel. They are made of porcelain—baked mud, if you please. Elaborate ones weigh 800 to 1,000 lb. and are relatively expensive. The steel structure of the building has to be made heavy enough to support one in every room. The same general proportions hold for toilets, lavatories, radiators, marble floors, etc.

Now the main reason why these fixtures are made of materials other than steel is that the steel-maker's mind has been imbued with the idea that steel must be made uniform. Such fixtures and apparatus made of one of the stainless steels would cost too much. But the new idea of using ordinary steel with a thin surface of stainless steel on the outside at a total overall cost of 5 or 6 cents a pound changes the picture entirely. The old conception of steel as a homogeneous product is giving way to the new idea of steel as a composite material of construction.

But the conception is not limited to bright and shiny corrosion-resisting surfaces—far from it.

Not long ago the railroads sent engineers into the rail mills to harden rail ends before they went into service, because the ends batter and wear first. If the whole rail were as hard as these specially treated ends, it would be too brittle for safety. Thus until a year or so ago, rails were uniform steel products. They are now becoming composite products with different physical properties at different locations.

High-Tensile Inserts to Replace Heavy Reinforcing

Throughout all of our machine design, from aircraft to lumbering steam locomotives, we have queer lumps of reinforcement to take care of stress concentrations, because our minds run along the traditional lines that metal must be uniform in physical properties and that the way to get more strength is to make it thicker and heavier. Presently we shall be welding in high-tensile inserts where they will do the most good.

It is in the design of pipe that we reach the heights of absurdity in carrying out the aforementioned tradition. No one has ever heard of a pipe conveying liquids or gases which had the same necessities to meet on the inside as on the outside. Yet the designer is forced to make some compromise and use a metal that is uniform inside and out. It does not do the steel industry any good when engineers choose cast-iron pipe in preference to steel pipe as the best compromise. It is quite likely that steel pipe which is different inside and outside will presently be offered for sale at competitive prices.

Throughout all living nature, nothing is uniform. It has taken us a long time to learn it, but all we can know about the design of anything, we have to learn from Nature. She has been working for aeons by trial and error. There is bark on a tree and hard wood around a knot-hole because only such conditions have permitted tree life to survive.

Designers Should Study Methods of Mother Nature

If we have insisted on making and using steel structures of uniform metal it is because we have never studied the experience and ways of the one great teacher of us all—Nature.

There are sound reasons why steel should not be uniform in chemical analysis or physical properties, and they lie close to the fundamental principle of all design. The first principle of design of any metal structure is that it shall just meet all the service requirements for the period of its normal life and that the cost shall be within economic boundries. This principle is not a dull academic pronouncement; it is alive and vital, as life itself.

Meeting service requirements means that the structure must be strong and safe, that it must behave satisfactorily under all service conditions and that it must be pleasing to the human beings that use it. Good design implies good appearance; a design is not good unless it has pleasing appearance, which is a utility function and as essential as long life.

Young designers often sneer at the spending of labor and effort in giving a machine or structure pleasing appearance. Good line and form is something their handbooks do not mention. But nature knows the utility value of good appearance. The flowers we saw in such a lovely profusion of colors at Easter

were not beautiful by accident, but by nature's design. The slender and graceful lily, demure in old ivory and cream with a splash of yellow, is nature's bid to bees and insects to come and drink the nectar in the lily's cup—and pollinize the lily. The lilies that are not lovely enough to get pollinized leave no successors. Beauty of line and form and color are attributes of utility.

This great and fundamental principle operates, and the steel industry has suffered from every violation of it. Because steel has been a uniform metal designed primarily for strength, civil engineers have drifted away from its use into the use of concrete, which is often believed to resist corrosion and degenerative disease better. It is a fact that during the service life of some steel bridges, more is spent for paint to keep them from rusting away than the steel cost. The bridge might be made of corrosion-resisting steel, but that would cost too much. Plating with nickel, chromium, silver, copper or gold would cost too much.

The only possible solution is to make steel which has low-cost strength on the inside and satisfactory corrosion resistance on its surface. Steel that is uniform from center to surface is doomed by the necessities of sound design. Steel structures in which the material is of uniform strength, although the stresses vary from high compression to zero to high tension, will give way to structures which have low-grade material where stresses are low and high-grade material where stresses are high.

Get "H. O. T." on Welding

By H. O. T. RIDLON

Commercial Candor in Mass.

Recently I was out Boston way where S-turns on the highways are marked "Reverse Curves." But, anyway, near Belchertown, Mass., I saw this sign, "Better Belcher Gas." I've always been told that's the thing to do; now I know it must be true.

* * *

Cow-Shed Sanitation Tip

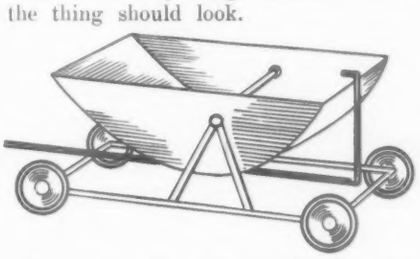
I wanted to draw you all a lot of swell pictures of things to make out of the old scrap pile. But between working like two or three kinds of devils, and acquiring a bit of this year's first tan playing a bit of cow-pasture pool over the week-end, I just haven't gotten around to looking at a drawing board for months.

But that reminds me, here's an idea for youse guys what have farm customers. As you know, the old "honey wagons" have been working overtime of late and the winter's accumulation is now about depleted. And many a farmer who hasn't the best of everything, still has clear in his memory a vivid picture of getting the stuff out to the old pile, and particularly on the cold and frosty mornings we had last winter. And he may be thinking of some quicker method of doing it these hot summer days that soon will be with us. So it seems that this is a swell time to sell that gent a grand idea, even if it is mine.

From old and/or scrap angle irons, about 1½x1½-in. stock, you can weld up a swell track running from inside the barn to where he really wants the next year's pile to be. Have this track with just a slight grade toward the pile, and have a right stout bumper at the end of it.

From scrap pipe or angle iron you can weld up the frame for your "honey hod." Then you can weld up your "honey hod" out of some scrap 20-gauge stock.

Here's a very rough sketch of how the thing should look.



Be sure that the weight is very slightly forward, and have an automatic release on it so that when it hits the bumper at the end of the track, it automatically dumps itself. So all Mr. Farmer has to do is load it up in the barn, give it a push, and away goes the "honey hod" right to where he wants his pile, and automatically dumps itself. Because of its very light weight, yet very strong welded construction, he can with ease pull it back to the barn with a rope.

I'd be interested hearing from you guys that build any of these, and would appreciate pictures if you can get them. But if you can't get pictures, tell me about it anyway. Would you like me to give you profit making ideas like these?

* * *

Lethal Chamber for Kitties

Well, while we're on such things, we might as well make this a complete rural issue, or nearly so anyway.

Another farm problem often coming up this time of the year is that of getting rid of puppies and kittens and the like, for there always, or nearly so, seems to be an over-production. And lots of farm folks are really "softies" when it comes to putting them to sleep. Well, my friends, the real humane way of doing the job is with gas. But, you say, where the something or other are we going to get gas on the farm?

Ah, here's the trick. Jimmy Dawes, of Pittsburgh, gave me the idea. You know it has been wisely said that you can take the boy out of the country, but you can never take the country out of the boy. But, anyway, Jimmie really is a grand guy, in spite of the fact that he has been peddling welding equipment these past 18 years.

Well, sir, here's the trick. Weld up a box out of 20-gauge stock, and have a trap door on it with a rubber gasket, and on one side bronze-weld a piece of 1-in. pipe, paint it up nice and supply a piece of hose with the outfit. And then sell it to Mr. Farmer to do this mean chore with. When he wants to put some pet to sleep he attaches the box to the exhaust of his flivver by means of the hose, puts the pet into the box and shuts the trap door tight, jumps into the car and starts the motor, and pronto in a few seconds the pet is sound asleep forever without any pain or mess.

* * *

The thought for the month: You have to believe in happiness, or happiness never comes.

Coming Events

May 25-27. Philadelphia, Pa., The Bellevue-Stratford. Annual Convention of the Heating, Piping and Air Conditioning Contractors National Association. For information write the Association, at 1250 Sixth Ave., New York City.

June 4-6. Chicago, Ill., 2211 W. Pershing Road. Midwest Welding Conference, including technical program and exhibits. (Program given on page 51.)

June 18-20. Ames, Iowa, Hotel Sheldon-Munn. Ninth annual convention of Iowa Blacksmiths and Welders Association, formerly known as Iowa State Association of the Master Horseshoers' and Blacksmiths' National Association of America. For information write John Turley, secretary, Zwingle, Iowa.

June 27-Oct. 4. Cleveland, Ohio. Great Lakes Exposition. For information write Ernest Smith, 3910 Carnegie Ave., Cleveland.

June 29-July 3. Atlantic City, N. J., Chalfonte-Haddon Hall. Annual meeting American Society for Testing Materials. For information write Society at 260 S. Broad St., Philadelphia, Pa.

Sept. 22-25. Detroit, Mich. Iron and Steel Exposition. Also annual convention of Association of Iron & Steel Electrical Engineers. For information write John Kelly, Jr., Empire Bldg., Pittsburgh, Pa.

Oct. 19-23. Cleveland, Ohio, Public Auditorium. National Metal Congress. Also Fall Meeting of American Welding Society and meetings of American Society for Metals, Wire Association, and others. For information write W. H. Eisenman, 7016 Euclid Ave., Cleveland.

Welding Simplifies Manufacture of Motor Frame of Complicated Design . . .

By D. B. CHARTERS,
Manufacturing Engineer, Westinghouse Electric & Manufacturing Co.

MANY pieces of machinery have been in the past prohibitively expensive because their complicated design made casting difficult. To get one perfect cast many pourings were necessary. Welding, however, is enabling engineers to build such parts quickly, cheaply and efficiently. This article explains how one of the largest electrical machinery manufacturers is using welding in this manner.

HOW welding has made possible the comparatively easy and economical construction of large, twin-armature electric locomotive motors of a design too complicated for successful casting is illustrated by the manufacturing of motive power designed for high-speed, heavy-passenger service on the Pennsylvania Railroad between New York City, Philadelphia and Washington, D. C.

Weight, strength and space are the three governing factors in this frame design, not forgetting, of course, the question of cost that is always with us. Fig. 1 shows the completed frame ready to go to the machining department. A study of this picture indicates what a formidable casting job it would be, with its thin and thick sections and generally complicated structure.

Twin Motors Composed of Two Barrel-Like Sections

Every one of these twin motors has two barrel-type sections. Each barrel consists primarily of a heavy ring at each end, the barrel connecting them together, and a reinforcing ring around the barrel near the center. The end rings were rolled on a small vertical three-roll-type bending machine, cut to length and the ends beveled for welding. The rings were left slightly oversize and dropped into a fixture (Fig. 2). By means of two eccentries, the ring was sprung to the correct size, tack-welded and then removed and the joint welded.

The ring was then placed in an indexing fixture for planing (Fig. 3), which located it in position central with the bore. This fixture was equipped with locations for the long flat, where the barrels were to be joined together, and a smaller flat at 90° from the main flat. This smaller flat was put on in rights and lefts, as it was used on all four end rings at assembly. This fixture was provided with a device for scribing a center line perpendicular to each flat, the purpose of which will be explained when discussing the assembly. After this operation the ring was ready for assembly.

The barrel plates were planed on a plate planer to the correct size and rolled into shape on a pinch-type roll. They were then dropped into another fixture (Fig. 4), where the edges were forced together with wooden wedges and lined up by means of wide-faced C-clamps. If the barrels were slightly skewed in rolling, the ends were evened up by means of a small crank-and-screw device, which can be seen on the top of the barrel.

After tack-welding, the barrel was removed from the fixture for welding. One bead only was used, which by means of slightly excess current gave penetration about one-half way through the plate, the welding of the remainder of the frame being so arranged that it was unnecessary to develop the full strength of the plate in the barrel. As mentioned before, the frames were of the twin-armature type and it seemed logical to go as far as possible with each single barrel before welding both barrels together into the twin unit, because of the simplified welding procedure.

Rings Located on Barrels by Ingenious Fixture

In using the barrel-assembly fixture (Fig. 5), the first ring was placed with its center line matching a scribe line on the fixture, and was then clamped in position. The barrel was dropped onto the first ring placed, and located by means of the three-armed centering attachment, which is actuated by means of the crank shown at the top of the column. The upper ring was then placed in the same manner as the bottom ring, by means of its previously scribed center line, and the three parts securely tack-welded together.

Around the center column of the fixture was built an indexing device for the spacing of the pads on which the frame punchings were to be built. With these twelve bars tack-welded in place, the single barrel was ready for welding. The outside fillet welds were made on an automatic welder (Fig. 6). A number of windows were later burned in each barrel, and those portions of the windows which extend out to the rings were marked so that welding at those points could be omitted. After all outside welding was completed, the barrel was mounted on a three-position tilting and rotating fixture (Fig. 7) for the inside welding.

Windows Burned in Frames by Hand-Torch

The locations of the windows were marked by means of band-type templates shown in use in Fig. 8. After completion of welding on the single barrels, the windows were burned in by means of a hand torch, and the units were then ready for assembly into the two-armature unit.

Because of the close tolerances which must be maintained in the fabrication of the frame, considerable thought was given to the making of an assembly fixture which would give satisfactory results. The foundation of the fixture was a heavy plate with setting blocks for the lower frame parts. Fig. 9 shows this plate, with the axle preparations clamped in place ready to receive the two barrels which have been previously welded.

Fig. 10 shows the two barrels in place with the upper framework used for locating the upper details. The rings have been planed to give the correct center distance between frames, the center lines serving as a check only. If the work has been done correctly up to this point, the three center points (that is, each barrel and the axle preparation) assume their proper relative positions, with all allowances for finish equally distributed. The foot braces were located by the ribs about the barrels or by hinged guides

Steps in Welding Twin-Barrel High Speed Motor

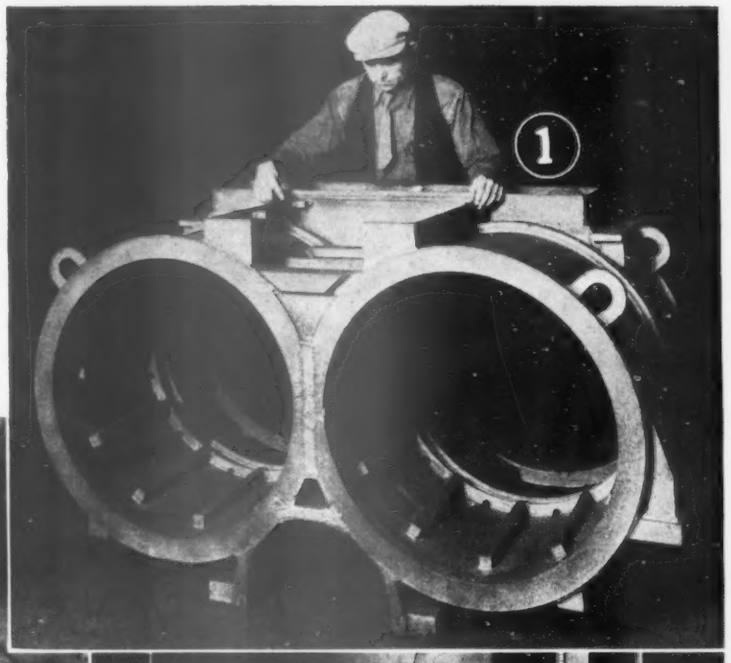


Fig. 1—Completed frames ready for machining. Such frames are considerably too complicated for successful casting.

Fig. 2—Welding ring fixture.

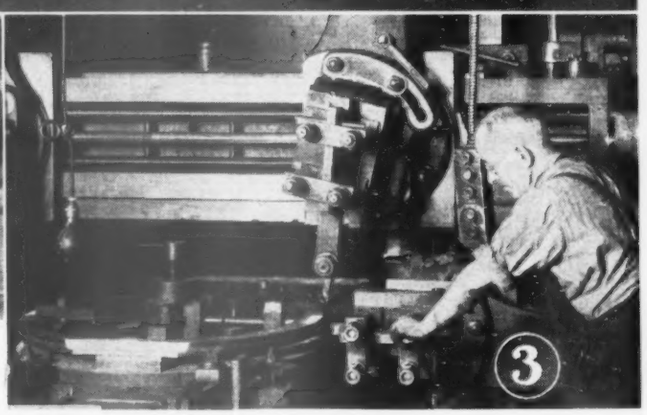
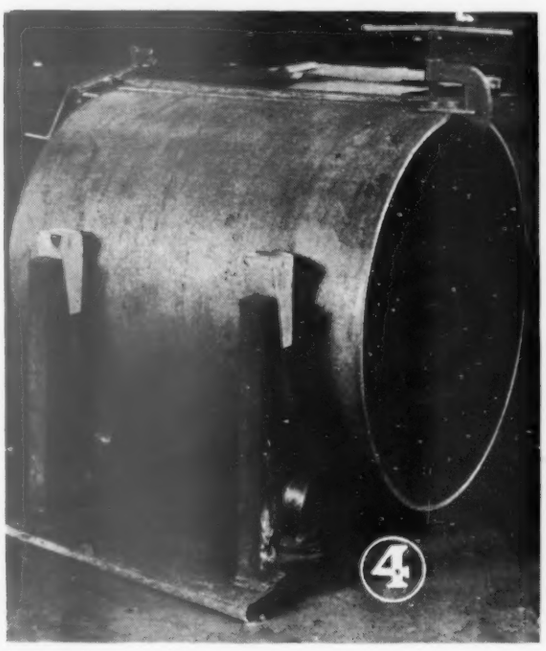
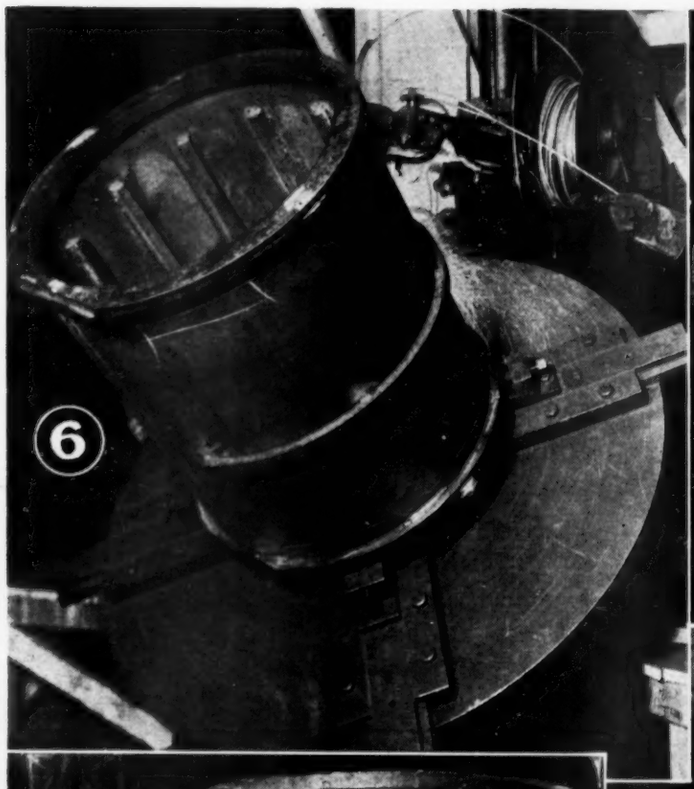


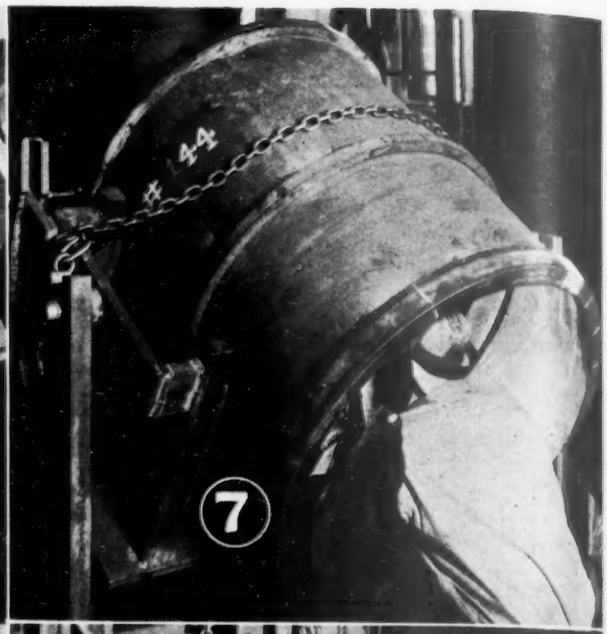
Fig. 3—Indexing planing fixture for rings. This fixture locates the rings in a position central with the bore, and fixes the positions of the long and short flats which hold the barrels together.

Fig. 4—After being rolled into shape, the barrel plates are put on this fixture, the edges brought together and tack-welded. Final welding is done off the fixture.

Fig. 5 — Rings are located on the barrels by means of this fixture, and tack-welded in place.







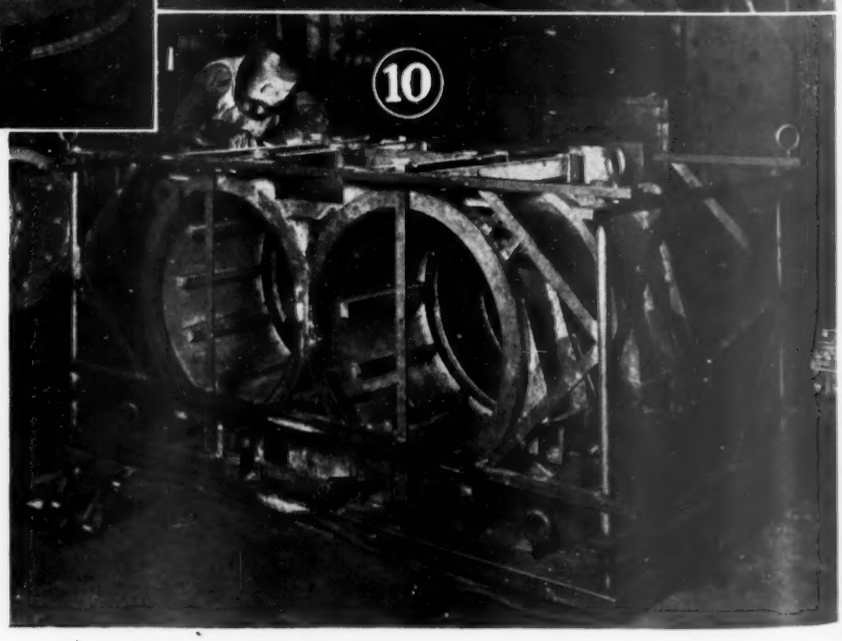


Fig. 6—Barrel in place on automatic welder.

Fig. 7—Welding inside the barrel was done on this 3-position tilting and rotating fixture.

Fig. 8—Windows to be cut in the barrels were marked with templates and burned with a torch.

Fig. 9—Placing barrel on the assembly fixture. Axle preparations are already clamped in place.

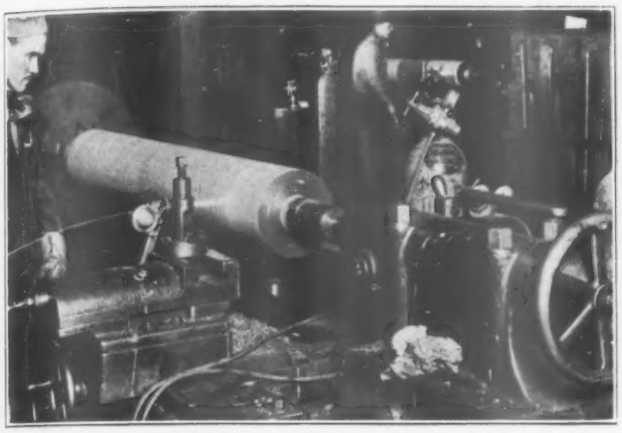
Fig. 10—Double-frame assembly fixture with everything in place. Upper details located by framework.

which swing free when the frame is to be lifted from the fixture.

There are two or three small items which are added after the frame is free from the fixture, but their location is not so important and no good purpose would be served by attempting to locate them in the fixture.

After welding the frame was strain-relieved and then machined.

Notes on Metal Spraying



Building Up Printing Press Cylinder With Monel Metal.

Reclaiming Printing-Press Cylinders

The metal-spray process is being used in increasing volume by the printing trade. Printing presses and printing rolls must be operated with extreme accuracy in view of the large diameters of the rolls or cylinders.

A large producer of waxed paper on the Pacific Coast had a 4-color press, the four cylinders of which had corroded while in operation, so the diameters were reduced between 0.002 and 0.003 in., resulting in an irregular surface which was detrimental to the product. The cylinders were approximately 9½ in. in diameter with an overall length of 87 in. Each had about 67 sq. in. of contact surface to be built up by spraying.

In order to resist further corrosion, and to bring the cylinders up to proper size, 35 lb. of ⅛-in. monel-metal wire was sprayed onto each cylinder.

As two cylinders were sprayed simultaneously, it required only two working days of 8 hours each to spray all four. The total elapsed time of 16 hours included the usual set-up time and the necessary time to take measurements. The accompanying illustration shows the building up of two of these cylinders.

The cylinders first were trued up by machining, and then a special bonding thread cut was applied. The customer required that they be finished to a diameter of 9.473 in. with a tolerance of only 0.0005 in. This was accomplished by grinding. The cylinders have now been in operation for a sufficiently long period to assure that they are entirely satisfactory.

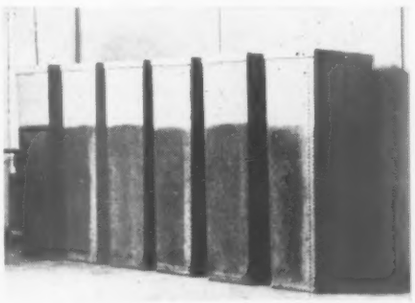
The job consumed 1,372 cu. ft. of acetylene, 1,490 cu. ft. of oxygen and 142 lb. of monel-metal wire. The replacement cost with new cast-iron cylinders would have been several times what the completed repair actually cost.

The work was done in the Los Angeles plant of the Metalspray Co., Inc., at 113 Llewellyn St.

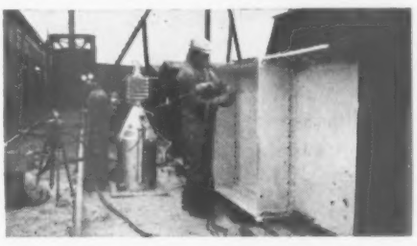
Applications of Sprayed Zinc

When a zinc surface is desired as a protection against corrosion or contamination, the metal-spray process is often used to deposit the coating. Among the interesting applications of zinc coatings made in this manner, the following are reported by the Metallizing Engineering Co., Inc., of Chicago, Ill.:

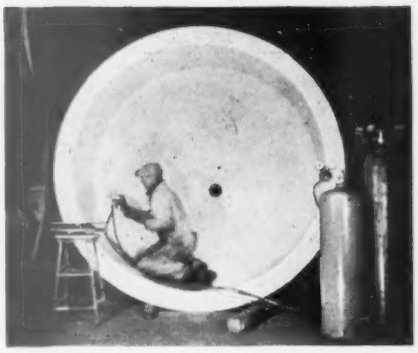
A bronze zinc-chloride vat was coated



Zinc Coating Protects Top of Ice Cans.



Coating Bridge Deck Girder With Zinc.



Spraying Vat With Pure Zinc.

(Though the vat is subjected to steam heat the zinc coating is not affected by distortion and temperature. Work done by Metallizing, Inc., Chicago, Ill.)

on the inside with 1/32 in. of "Meteo" pure zinc, using the "Metallizing" process. Zinc was used primarily to prevent contamination of the finished product, which must be kept as chemically pure as possible. The vat itself is steam-jacketed and therefore is subjected to an appreciable amount of distortion and heat. The "Metallized" zinc coating has been found sufficiently elastic to withstand such conditions.

A number of ice plants have found that the life of ice cans can be considerably prolonged by spraying the tops, inside and out, with zinc, thereby eliminating rust and preventing contamination of the ice. A coating of zinc, 0.009 in. thick, not only restores corroded cans to service, but in many instances the zinc-sprayed portions of such cans have outlasted the uncoated portions. It is claimed that the first cans thus "Metallized" are still giving satisfactory service.

The spraying of structural parts with corrosion-resisting metals is not new, but interesting applications of this kind still come to light. The spraying of zinc onto members of railroad bridges has been found to give effective protection against the severe corrosion action of brine drippings from refrigerator cars. The Canadian National Railways have experienced excellent results on a bridge in Toronto that has now been in service for approximately three years.

A manufacturer of dishwashers and kindred equipment is coating the inside of the water tanks with sprayed zinc. The water in these tanks is held at a temperature of 140° F., and the rinse water is at boiling temperature.

The application of Diesel engines to automotive purposes has been made possible largely through the use of molybdenum steels, which have enabled designers to reduce the weight without sacrificing strength.

Lack of magnetism is a characteristic of austenitic steels, which include 11 to 14% manganese steel, and 18-8 stainless steel.

NEMA Offers NEW STANDARDS to Arc Welding Field . . .

By A. LESLIE PFEIL

Chairman, NEMA Technical Committee on Standards for Electric Arc Welders

THE arc-welding field has not had officially codified standards that matched those which the industry recognized as current practice. Now NEMA has prepared a set that will clear up many vexatious problems, and will enable the buyers and users of arc welders to compare various machines and operations accurately. These standards define many terms which have hitherto been subject to various interpretations.

CAN YOU imagine a world without standards? How could you tell your own weight? How could you tell how fast or how far your car had traveled? How could you know what your pay envelope or check amounted to? A chaotic world, indeed, would we have without standards! Yet for about four years now the arc-welding industry has not had an officially codified set of standards on welding equipment that really were the same as those that the industry recognized as current practice.

Standards Are "Yard-Sticks" for Measuring

A "standard," according to no less an authority than Noah Webster, is that which is established by general consent as a rule for measuring—as a model, example, criterion or test. In the parlance of a well-known statesman, we may therefore look upon a standard as a "yard-stick" by which to measure whatever we are considering, be it the speed of your car or the size of a loaf of bread your wife buys for the table.

NEMA is an abbreviation used in the electrical industry for the National Electrical Manufacturers Association, composed of business men who have to be constantly on the alert to meet changing needs of their customers. The time for bringing standards up to date seemed appropriate early in 1935, and accordingly the job was undertaken at that time by NEMA.

One of the troublesome things about a code or set of laws or standards is that it never can be up-to-date. Custom and practice are ever in a state of change, and by the time such customs or standards are generally accepted and recognized, new factors have entered the arena and the "rules of the game" have to be rewritten. This is especially true in the arc-welding field—developments have been so rapid, and the changes so great that brave indeed is he who dares to accurately predict the trends of even a year hence.

Why should we have standards on arc welders? For one thing, you or your boss has to buy a welder every once in a while! Without an accepted standard by which to measure welder design and performance, you or he would be at the mercy of a wild crowd of manufacturers' salesmen, each claiming his particular size of welder was adequate for the job you wanted done. One salesman would call his machine a 350-ampere machine, the other call his a 275-ampere machine, yet both might be actually identical in electrical size and arc-welding performance, and nearly identical in price. Standards on welders, therefore, tend to clear away the inevitable haze of claims and counter-claims that surround a buyer who is seeking facts and truth. Even with definitely known standards, the welder salesman still can find plenty of superiorities to claim for his own product—some true, and some pure "blue sky."

Why Are New Standards Needed by Welding Field?

Standards have changed because your practices have changed. Consider this brief bit of history. Up to four years ago, bare-rod welding was still predominantly popular, and the old NEMA standard 25-volt welder was suited to it. Along came the shielded-arc rod, requiring arc voltages up to 40 volts, and you found you could not get anything like full amperage from your old welder for these new rods.

A new 40-volt machine standard was created to meet your needs. Fortunately, most manufacturers were in agreement in the ratings of the product they offered you—and they merely took the old welder ampere ratings and built for 40 volts instead of 25 volts. The new standards now cover the 40-volt machine.

Some time later one or two manufacturers attempted to revive the old mercury-rectifier idea for arc welders. There were no standards. They were not even mentioned in the old standards. How could you know what you were buying? The new standards cover rectifier welders now in as complete a manner as present experience permits.

Transformer Arc Welders Become Suddenly Popular

Within the last two years certain large manufacturers of welders have espoused the cause of the old transformer arc welder, basing their move on the successful performance of these units in certain heavy automatic and manual welding operations with newly developed types of shielded-arc electrodes especially suited to alternating-current arcs. Almost overnight the country was flooded with a wave of a.c.-arc propaganda. A host of manufacturers, large and small, jumped into the transformer-welder business with their own particular types and sizes of welders without any regard to engineering standardization, because there were no very clear standards.

The new standards have attempted to define transformer-welder sizes, voltages, output ratings, temperatures, insulation requirements and other important factors having an important influence on the performance and life of equipment, and the safety of those who use it.

Still another development was brought about by the introduction of the newer alternating-current, shielded-arc electrodes—namely, the rotating phase-changer frequency-changer type of a.c. arc welder. The old standards did not even recognize this type of machine. Why should not buyers be entitled to the protection of recognized engineering standards on the new units of this type that are coming on the market? The new NEMA standards cover these rotating a.c. welders. It may take a little time for manufacturers to fall in step

and follow these standards, since expensive changes may be involved. Buyers, however, have in these standards a "yardstick" by which to judge and evaluate this particular type of equipment.

Buyers and users of arc-welding equipment should give careful study to these NEMA standards, since they have been written for their protection and benefit.

Standards for Direct-Current Welding Generators

The type of welding equipment with which users of the arc-welding process are most familiar is the motor-generator set of the direct-current arc, variable-voltage type. Such a standard NEMA unit is built for operation in any atmosphere not exceeding 40° C. (104° F.) and at altitudes not exceeding 3,300-ft. above sea level. The machine is also capable of operation where exposed to the gas and dust produced by the arc, and where exposed to salt air, as in ship-board or sea-coast use. Its insulation materials are of cotton, silk, paper and similar organic substances, which must be impregnated with suitable insulating varnishes. The wire used in the machine may be of the enamel-coated type, or of a type employing one of the above insulating materials.

When the unit is operated at full-rated voltage (40 volts in all sizes, except 30 volts in 100 amperes and smaller) and at its full-rated current for one hour, its temperature rise in general does not exceed 50° C. (90° F.), and its total temperature does not exceed 90° C. (194° F.). The welder unit is capable of readily welding from 30% of its ampere rating at 20 volts, as for bare rod, up to 125% of its rated amperes at 40 volts, for machines of 200 amperes or larger, or at rated amperes at 30 volts for machines of 100 amperes or less.

These direct-current-arc type of units built under the NEMA standards are to be available only in the following official ratings: 50, 100, 200, 300, 400, 600 and 800 amperes. Any rating other than those given does not conform to NEMA standards and must be considered an "off-standard" or bastard rating.

"Off Standard" Machines Do Not Conform to NEMA Ratings

Ratings such as 75 amperes, 125 amperes and 150 amperes are offered by some manufacturers, and are intended to conform to the general spirit of the NEMA specifications as to all matters except ratings. Still other machines are offered as "special" units that carry nominal NEMA official amperage ratings, but really do not equal NEMA temperature-rise definitions.

Neither of these "off-standard" types of units are NEMA machines, and the buyer has only his own test facilities, or his confidence in the integrity of the manufacturer, as his guide or "yardstick" by which to measure whether he is getting value received. It is hoped that at an early date this confusing practice by a few manufacturers will be discontinued.

It would seem appropriate at this point to discuss the question of how much overload a NEMA welder unit is supposed to stand. The current range marked on the manufacturer's name-plate indicates a possible 25% overload capacity. When so operated, the machine is only to be used in an intermittent type of welding service, such that the quantity of heat generated within the machine does not exceed the amount of heat that would have been generated had the machine been operated at full normal load, full voltage, for one hour. Under average conditions a NEMA machine starting cold may be operated at 25% overload setting for approximately ½ hour, without injury to its insulation. This time estimate is conservative.

Welder generators of this type are designed to withstand reasonably long periods of operation at normal open-circuit voltage. To cover this point the new standards specifically say that the equipment shall be capable of operation for two hours at the open-circuit-voltage setting (no welding load) that is required to obtain 125% of the normal rated amperes output at normal rated voltage.

Temperature Rise Must Stay Within Safe Limit

The equipment is to do this with total temperature rises not exceeding those already indicated in a preceding paragraph for loaded welders. This definition is important, because without it a manufacturer could furnish the user of welding equipment with a unit which, if left running at the maximum output setting for some time, may reward its owner with burned-out field coils that have to be replaced. Fortunately, most manufacturers have for a long time recognized that this danger had to be provided against, and breakdowns resulting from open-circuit operations have not been as frequent in late years as formerly.

On the electric-motor-driven d.c. arc welder the driving motor has for years been given a horsepower rating more or less fictitious. In order to give the plant electricians accurate information for cable sizes, welder-motor name-plates now show the current drawn by the motor when full-rated welding load is being taken from the generator. The old horsepower rating was misleading and served no real purpose, except in some cases to dupe the buyer into the belief that all competitive welders had comparable efficiencies.

Alternating-current arc welders are defined as being of two types—the rotating motor-generator type and the transformer type. The NEMA rotating motor-generator a.c. welder must meet the ratings and temperatures laid down in the standards for the d.c.-arc type of machine. The transformer welder, on the other hand, is given a special basis of rating of its own.

Transformer-Type Welders Have Conservative Standards

Transformer-type arc welders are so rated that when the welder is operated at normal current rating and normal arc-operating voltage rating for a period of one hour on units rated at 300 amperes or over, and ½ hour on units rated below 300 amperes, the temperatures attained are roughly comparable to those for d.c.-arc motor-generator sets. Transformer welders must be able to withstand a no-load heat run at full open-circuit voltage for 2 hours, with the equipment set to deliver rated amperes and rated voltage output, without exceeding the normal temperature limits. The table at the bottom of this page indicates the standards as laid down for transformer welders.

The standard NEMA a.c. transformer-type arc welder is built so that its open-circuit voltage is not in excess of 80 volts, when rated name-plate voltage is impressed on the primary or input winding. Taps may be provided, however, to give from 70 to 100 volts output open-circuit voltage.

Rapid, Disorganized Growth Produced Many Bases for Rating

Unfortunately, the recent disorganized, rapid growth of the transformer-welder business has brought all sorts of bases of rating into existence, each manufacturer determining these according to his own judgment. Particularly

Current and Voltage Ratings—A-C Transformer Type Arc Welders.

Normal Rating Amperes	Rating in Amperes Continuous		Loaded Voltage	Current Range With High Frequency Stabilization Min.	Current Range With High Frequency Stabilization Max.	Current Range Without High Frequency Stabilization Min.	Current Range Without High Frequency Stabilization Max.
75	¼ hr.		60	5	75	50	75
150	½ hr.		100	15	150	50	150
				Current Range			
				Min.	Max.		
300	1 hr.		225	40	60	300	
500	1 hr.		375	40	100	500	
750	1 hr.		575	40	150	750	
1000	1 hr.		750	40	200	1000	

is this true of those making the smaller sizes, under 300 amperes. The result is that unless the manufacturer's nameplate on the transformer-type arc welder definitely indicates a rating in accordance with NEMA standards, the buyer of this type of equipment has no way of knowing what he is getting. Most manufacturers have indicated their willingness to standardize, and it is to be hoped that in a year or so the chaotic state of the present small-transformer situation will correct itself.

The rectifier type of arc welder has not yet come into sufficient use to make available enough experience and data on which to base adequate standards. The ratings of rectifier welders are to be the same as those now standard on other d.c. single-operator, variable-voltage arc welders. The temperature rise of the various transformers and reactors of these rectifier welders is to conform in general to the requirements for transformer-type welders.

New NEMA Standards Define Loosely Used Phrases

The new NEMA standards include some new definitions covering phrases which various welder manufacturers have used without any commonly accepted or well-understood meaning. One of these is "time of recovery," another being "current-recovery ratio," and still another "dynamic short-circuit ratio." Some of the more interesting definitions are given as follows:

TIME OF RECOVERY—The time required to attain conditions which are within a specified amount of their final value, in an automatically regulated welding circuit, after a definitely specified disturbance has taken place.

CURRENT-RECOVERY RATIO—With a welder supplying a short-circuited resistance load whose resistance is equivalent to the load setting on the welder, the short-circuit is suddenly removed. The ratio of the minimum transient value of current upon the removal of the short-circuit to the final steady-state value is the current-recovery ratio. (This ratio is used by the U. S. Navy as its "yardstick" for the inherent stability of a welder unit.)

DYNAMIC SHORT-CIRCUIT RATIO—The ratio of the maximum transient value of a current, after a suddenly applied short-circuit, to the final steady-state value is the dynamic short-circuit ratio. (This ratio is an effective measure of the tendency of a welding unit to cause an explosive type of arc when welding.)

EFFECTIVE CURRENT OVERSHOOT—The current overshoot immediately after a suddenly applied short-circuit may exceed the steady-state value by a large amount for a short period. The area of this excess of current over the normal value shall be known as the effective overshoot expressed in ampere-seconds or coulombs. (This factor very nicely determines the tendency of a welding unit to cause the electrode to stick to the work.)

STATIC SHORT-CIRCUIT RATIO—The ratio of the steady-state, short-circuit current of a welder at any setting to the current at rated voltage for the same setting is the static short-circuit ratio. (This ratio is a fairly good measure of a welding unit's ability to produce the electrode's metal-drop "pinch effect" which makes vertical and overhead welding easy or difficult. The U. S. Navy says the ratio must be 1.1 or more.)

STATIC VOLT-AMPERE CHARACTERISTIC—The curve which gives the terminal voltage of a welder as ordinates plotted against output load current as abscissae, at a fixed setting and a fixed supply voltage is the static volt-ampere characteristic of the welder for that setting. (This curve by its steepness tells fairly well how steady the arc current will probably remain under varying voltage resulting when drops of metal pass through the arc.)

VOLTAGE RECOVERY—With a welder supplying a short-circuited resistance load whose resistance is equivalent to a load setting on the welder, and measurement is made when the short-circuit is suddenly removed, (a) the time of voltage recovery is defined as the time measured in seconds between the instant the short-circuit is removed and the instant when voltage has reached 90% of its steady-state value; (b) the voltage overshoot is defined as the ratio of transient-peak-voltage value substantially instantaneously following the removal of the short-circuit to the normal steady-state-voltage value; and (c) the effective voltage overshoot expressed in volt-seconds is defined as the area under the transient voltage curve during the time that the transient voltage exceeds the steady-state value.

The keen user and buyer of welders may well question the need for the foregoing definitions and ratios. The scientist who devotes his thought to the improvement of the welding art may question the wisdom of defining ratios without tying each ratio down to the definite maxima and minima which experience has indicated as proper.

To be sure, such limits for the values of the ratios just defined have been arbitrarily set by certain specification-writing agencies, based on their individual experiences or research.

Importance and Value of Ratios Are Subject to Controversy

There is, however, quite a divergence of opinion among authorities as to the values that are adequate for these ratios, and also as to the relative importance of each ratio, in determining what weighting they should receive in evaluating the performance of a welding unit.

Until further experience in the welding art has produced more conclusive evidence than now exists as to the right values to be assigned it seemed best in drawing up these standards merely to recognize the need for definitions, so that the industry would at least know what was meant when these terms were used.

Every buyer and user of electric-arc-welding apparatus is entitled to full information on which to base his judgment in the selection of arc-welding equipment. The new NEMA standards are a conscientious effort to make this possible. The committee which drew up these new standards for NEMA included: C. J. Holslag, Electric Arc Cutting & Welding Co.; L. D. Meeker, General Electric Co.; S. C. Osborne, Wilson Welder & Metals Co.; A. L. Pfeil, Universal Power Corp. (chairman), and W. W. Reddie, Westinghouse Electric & Manufacturing Co.

The committee received the cooperation of all manufacturers. F. S. Dellengbaugh, of the Ratheon Co., assisted the committee with recommendations for standards on rectifier-type arc welders.

The standards, complete, have just recently been published by the National Electrical Manufacturers Association, 155 East 44th St., New York, N. Y., from whom they can be obtained at 50 cents per copy.

Welding Used in Rackhouse Construction

Welding is being used in the erection of rackhouses at distilleries in Peoria, Ill. All exposed nuts, bolts, and screws on the windows and doors are spot-welded to prevent them from being pried open. This is a government specification in the bonding of these rackhouses. Barrel conveyors are also of welded construction.

At the Century Distillery, one rackhouse is being constructed and it is rumored that an old one will soon be replaced by a new one.

At Hiram Walker's, the world's largest distillery, rackhouses No. 5 and 6 are under construction. The roofs of these are of sheet metal and are spot-welded to the roof trusses and purlins. The door casings are of steel, welded to the reinforcing bars, and set in concrete.

Hiram Walker has purchased a large tract of ground adjacent to the distillery, and it is rumored that more rackhouses, two pump houses and a large cooperage shop will be built on it. If they adhere to their present code of building, a considerable amount of welding will be involved.

Builds Up Cast Wheels With Manganese-Steel Plates

The blades of two race wheels were recently built up by welding manganese-steel plates onto them with 18-8 stainless-steel electrodes. This method increases the life of the wheel and the output of the pump of which it is a part. The work was done by the Superior Welding Co., Peoria, Ill., for the McGrath Sand & Gravel Co., of Chillicothe, Ill., and was so successful that the McGrath company recently had a new cast wheel sent straight from their foundry at Wauheegan, Mich., to be treated in the same manner before installing it.

Many other manganese jobs were recently completed by the Superior Welding Co. Among these were three large hammers from a pulverizing mill, built up with hard-facing electrodes. A number of clamshell-bucket teeth and dipper teeth of steam and gas rigs were also built up with manganese steel, then surfaced with hard-facing material.

Resistance Welding—V

Theory and Application

(Fifth of a series of articles)

By L. H. FROST

Welding Engineer, The Electric Controller & Mfg. Co.

THE electrodes deserve more consideration than is ordinarily given them in spot-welding machines. They are important in that they deliver the electrical output of the machine, control the area of the weld and remove heat from the outer surfaces of the pieces being welded. The effect of pressure of the electrodes has already been discussed, and some of the factors affecting the use of various electrode materials have been mentioned. These factors are principally the composition of the electrode, its shape, and the efficacy of the electrode in cooling the outer surface of the welded pieces.

There are many compositions and alloys of copper available for use as electrodes, but relatively few of these combine many of the most desirable characteristics. The material should be of such electrical conductivity that a minimum of resistance occurs at the outer surfaces. Copper is commonly used because it fits this requirement better than any other commercial metal. A further requirement is that the material resist a tendency to change its shape due to heat and pressure. In machines requiring high production, ordinary copper is definitely undesirable in this respect since it softens and changes its shape under moderate heat and pressure. Another requirement is that the material be of high thermal conductivity or heat-carrying capacity in order to quickly and steadily carry the heat away from the outer surfaces.

Copper a Better Electrical Conductor Than Any Alloy

Many alloys of copper and other materials have been made to meet these requirements. Since any alloy will have some of the characteristics of each of the component metals, no copper alloy in commercial use has an electrical or thermal conductivity as great as pure copper. This means that the alloys will not carry the current through or the heat away from the pieces being welded as well as copper. However, as compared to the materials being welded, the electrical and thermal conductivities are high and in most cases satisfactory.

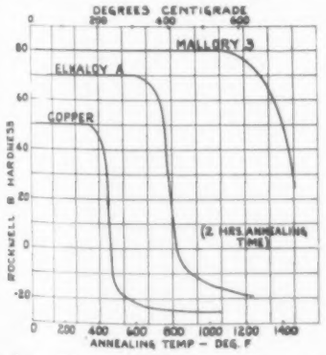


Fig. 14. These Curves Show that Alloys Retain Their Hardness at High Temperatures Better than Pure Copper.

For instance, Mallory No. 3, one of the common high-strength copper alloys, has an electrical and thermal conductivity as high as 90% that of pure copper, and many times that of mild steel. Thus with respect to the steel the characteristics of the alloy are practically equal to copper.

Care Needed When Using Copper Alloys in Welding Aluminum

Some of the high-strength copper alloys have an electrical conductivity only 25% that of pure copper. While these alloys may be used satisfactorily with steel, caution must be taken if satisfactory results are to be obtained when welding metals of higher electrical and thermal conductivity such as aluminum, brass and other alloys of this nature.

The purpose of using the high-strength copper alloy, then, is to minimize the change in shape under conditions of heat and pressure. The most common alloys of copper used for electrodes contain cadmium, chromium, beryllium or tungsten as the alloying element. The percentages of these elements are very small as compared to the copper content—the cadmium and beryllium groups containing 3% to 5%, the chromium group about 1%, and the tungsten group in equally small percentages.

The cadmium and chromium groups give 75% to 90% conductivity with a maximum hardness of approximately 80% on the Rockwell B scale; and the beryllium group gives 25% conductivity with a maximum hardness greater than the cadmium group.

The effect of heat on the softening of electrode material is shown in Fig. 14, which gives curves for hard-drawn copper, Elkaloy and Mallory No. 3, which are alloys from the cadmium and chromium groups. While the data in these curves are based on annealing for two hours, at each measurement taken to plot the curves, the results are comparable with the effect of annealing found in actual electrode use. The curves show that the alloy materials can stand higher temperatures without softening than can pure copper.

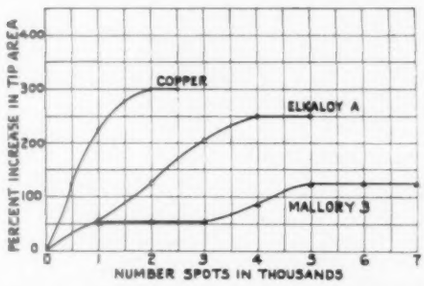


Fig. 15. Hard Copper Alloys Have Longer Life than Pure Copper.

The combined effect of heat and pressure in changing the shape of electrodes is shown in Fig. 15. These curves show that in actual welding conditions the hard copper alloys have longer life. Actual production experiences in many plants also confirm these figures.

While the hard copper alloys give longer life to the commonly used cone-shaped electrodes, an important use is for special electrode shapes that are too difficult to maintain when made of ordinary copper. The use of special shapes to fit the particular job permits the satisfactory welding of parts and alloys that could not be suitably welded with conventional electrodes. It is common knowledge that by using a large, flat electrode on one side of the welded part and a conventional cone-shaped one on the opposite side, the surface appearance on the side contacting the large, flat electrode is materially improved with regard to heat stain or oxidation and surface indentation.

Stain and Indentation Avoided Shaping to Fit Contour of Work

In this connection, shapes to fit special contours permit only the necessary minimum of stain and indentation, and in order to increase the number of welds obtainable from one dressing it is often desirable to use the hard copper alloys. Electrodes for this condition must be designed as the particular occasion arises, and an understanding of the thermal gradients as shown in Fig. 3* will help in the design of such electrodes.

With reference to Fig. 3*, it is apparent that if a large, flat electrode is used on one side, the thermal gradient as shown at *B* will not be as great on that

*"Resistance Welding—I," by L. H. Frost, page 44, *The Welding Engineer*, Jan. 1936.

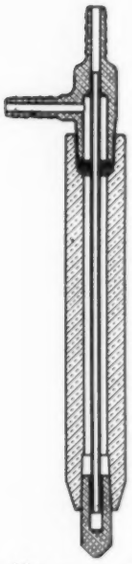


Fig. 16. Section of Electrode in Which the Cooling Water Is Carried Close to the Electrode Tip.

side as on the other since the current is dispersed over a greater area.

This is apparent when welding a thin piece to a thick one. If the weld is to be made in such a way that minimum surface mar occurs on the thin section, then a large, flat electrode must be used against that section. In order to concentrate the current flow in a relatively small area where it passes between the sheets it is necessary to use an electrode whose contact area is considerably smaller than the weld area. This weld can be made provided the ratio of thicknesses of the sheets is not too great. Specific data on such applications are not given here, as each problem can best be solved by experimentation.

Metals of Narrow Plastic Range Need Special Electrodes

Another case in which a special electrode shape is desirable is in the welding of metals having a narrow plastic range. Such a metal is aluminum, which changes from the solid to the liquid state with practically no plastic range. In this case it has been found desirable to use an electrode of such shape that while the weld is being made a small area is in contact with the work and as the metal is displaced more of the electrode comes in contact with the work, thereby lessening the indentation and minimizing the sticking of the electrodes to the work. With such electrodes it is commercially practicable to weld the softer aluminum alloys.

In the above cases it is evident that hard electrode alloys will minimize electrode dressings and that dressings must be made in a suitable machine, such as a lathe, and *not* with a file. Accurate and dependable welds cannot be made when electrode tips are dressed by one who is not an expert with a file, and few men are. For ordinary rough work a file may be used, but its use cannot give consistent results in such cases as outlined above.

The third function of the electrode is to remove heat from the outer surfaces of the pieces being welded. To accomplish this, there must be some definite means for maintaining the electrodes at a low temperature. This is accomplished by water cooling the electrode, and most machines are so equipped. For almost any production speeds this is not enough—the cooling water must be carried as close to the work as practicable. Fig. 16 is a sectional drawing of a complete electrode in which the water cooling is carried as close to the work as practicable. Some form of electrode such as the one shown is to be preferred to forms where cooling water is not carried so close to the work. Another advantage of this type is that the operator may be supplied with a sufficient number of properly dressed removable electrode tips for the day's run, and thus eliminate any chance of improper dressing of the tips.

The importance of proper care of electrodes and tips is appreciated by relatively few shops, but those who understand and practice proper electrode control are amply repaid in the improved quality and appearance of the welds. The above discussion does not attempt to cover the subject in detail, but to give a general outline of proper methods. The subject is of such a nature that a knowledge of the general principles can with minimum experimentation solve each problem as it comes along.

Huge Welded Cylinders Will Carry Gasoline on Barge

By EDWARD H. SYKES
Pittsburgh Correspondent,
The Welding Engineer

Aetna Oil Service, Inc., refiners, of Louisville, Ky., have just purchased a mammoth barge, equipped with four large, all-welded tanks, for the transportation of casing-head gasoline on inland waterways, principally between their plant and St. Louis. It is the first barge to be purchased by the Aetna interests, the company having formerly operated leased barges, and is further evidence of the growing importance of waterway transportation.

This huge barge, 175 ft. long and 10 ft. deep, with a 27 ft. beam, was built at the Leetsdale, Pa., works of the Bethlehem Steel Company, on the Ohio river about 12 miles below Pittsburgh. Because casing-head gasoline is highly volatile, the Aetna Oil Service, Inc., decided upon all-welded cylinders designed to carry a working pressure of 10 lb. per sq. in. The four cylinders, which are 62 ft. long and 12 ft. in diameter, have a total capacity of 6,000 bbls.

The tanks were tested to 25 lb. per sq. in. by a hydrostatic head. This was accomplished by Bethlehem engineers, who filled them with water and pumped them up to 25 lbs. pressure.

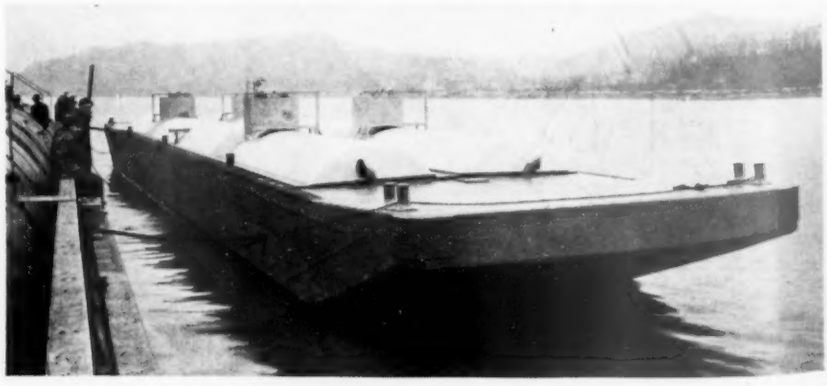
The details of design, and construction, were worked out by W. T. Davis, vice president of the Aetna organization, and the launching took place on the marine ways at Leetsdale, March 2.

The construction details of these large cylinders are unusually interesting. Each tank has carbon arc-welded longitudinal seams, while the transverse seams are metallic arc-welded. Five-sixteenth inch steel plates were used in the construction. A sump in the bottom of each tank permits complete drainage and ease in cleaning, handling and gauging.

The barge itself is of heavy riveted construction, and the tanks are set in it. This gives the effect of a double-skin barge, and adds protection from punctures or other damages. While this type of construction costs a little more than a single-skinned barge, the many advantages more than offset the difference in price.

The tanks are equipped with all the latest safety devices, including safety vents, flame arresters and automatic float indicators. Should the casing-head gasoline work up a pressure greater than 10 lb. per sq. in., the excess pressure will be automatically vented.

The barge was inspected and classed by the American Bureau of Shipping.



Last Word In Gasoline Transportation.
(The two welded tanks have a 6,000 barrel total capacity, and are equipped with every safety device.)

FIRE DEPARTMENT Solves EQUIPMENT

PROBLEM by WELDING — Saves $100,000 . . .

By ORN T. WEIRS

IT TAKES the well-known fighting spirit of American fire departments to "beat the hide" off the Devil Depression that has been chewing up the world since 1929. This past year they surprised the country by holding the aggregate property losses down to a lower figure than at any time since 1916—to approximately only half of the 500 million dollar yearly average from 1920 through 1932.

As gratifying and significant as this accomplishment is to fire officers and "blueshirts" everywhere, the Jersey City, N. J., department was nevertheless quite worried recently. Though their own record for the year was, as usual, among the best for cities of its class and hazards, yet when Thomas J. Wolfe, Commissioner of Public Safety, dropped into fire headquarters with congratulations, Fire Commissioner Flaherty and Chief Roger Boyle were feeling quite too glum to be greatly cheered by any kind words of appreciation.

Broken Equipment Endangers Lives of Firemen

"Why, look at the reports they're shootin' in to us all the time now," they chorused, "steering knuckles breaking so frequently on those old front-drive ladder trucks that the men expect it every time they 'roll'; the wheels and all the joints wobble so's a blind man could see 'em; and the solid tires are pounding everything we've got to pieces.

"We just welded up one broken chassis. Now No. 3 truck calls in, sayin' the top flange on the right side of their frame is split clear across—liable to fall in the road any day and kill or injure several good men. Those old trucks have certainly given us service; but they were bought before the war, and now they're plumb worn out. Yes sir, Tom, we've got to do something pretty quick, or otherwise the Underwriters will have to raise insurance rates on us, and our record next year can't possibly be anything to spout about. But this blamed depression . . ."

"Aw, cheer up," laughed Commissioner Wolfe. "While you boys were telling me all those sad details, I got an idea—a very good idea. Now, instead of welding and patching up those old trucks any more, why don't you just get yourselves the necessary materials, and then get busy and weld us up some entirely new trucks? This ol' town is the home of oxyacetylene welding in America, in case you don't know it; so you boys certainly ought to be able to show 'em how it's done."

"Yeah? With the depression still snortin'?" grinned Boyle and Flaherty. "No foolin'—you tell us about it."

"Shure as ye sit there, I will that, and as soon as I see the Mayor about it. You'll be a hearin' from me later, and don't you forget it."

Thus it happened that seven new hook-and-ladder trucks, like the one shown in the accompanying illustration, have just been turned out by Deputy Chief Myles J. Burke, in charge of Jersey City's Fire Department shops. The cost of each of these trucks, complete with its G.M.C. enclosed-cab tractor, was only $3,500—a saving of $12,000 to $15,000 per truck, or a total saving of approximately $100,000 for this city.

Welding Made Possible Seven Trucks Like This One.
(Jersey City's fire department reconstructed this equipment out of discarded parts considered to be ready for the junk heap.)

The 6-cylinder tractors are rated at 34 hp., but actually develop 75, and easily haul the trucks around the grades in Jersey City's streets. With the exception of the aerial-ladder turntables and their related mechanism, and also the rear axles for the ladder trucks (these parts being salvaged from the abandoned equipment and built up by welding and otherwise reconstructed to be in perfect condition and up-to-date) everything back of the tractors is all newly constructed. Seven-inch channel iron, more than ⅜ in. thick, has been substituted for the thinner 5-in. channels, such as were used in the old truck frames which cracked. The new frames are also specially reinforced against weaving, which was objectionable in the older trucks—this being eliminated by the design of the brackets which support the ladders in very neat and accessible stacks. Incidentally, the 100 ladders (including those of the truss-type design) which were required for these seven trucks were all made up new in the Fire Department's shops by men who have devoted their lives almost exclusively to that particular kind of work.

Cost of Some Items Reduced by 93 Per Cent!

The 20-in.-wide running boards of welded checker plate are considerably inside the lines of swath the tractor cuts through traffic; and they are notably unencumbered with the usual fire-department tools, which are, however, most conveniently and accessibly grouped in very plain sight. By utilizing built-up and welded constructions wherever possible, the various parts required for attaching these tools to the trucks were made for as little as 7% of what the same parts would have cost new, and most of the other welded items were constructed at similar savings. An idea of the amount saved can be gained from the fact that one item alone—a holder—would have cost $35 for each truck, if purchased new.

Complete and ready to "roll," the trucks weigh 10 tons each. They are 56 ft. long overall, 7 ft. wide, and the clearance is 9 ft. with no "ducking" required

of the tiller-men, who have electric communication with the drivers.

A few inspection walks around these immaculate, white trucks—a color readily seen and distinguished in traffic—and one is impressed and amazed by the fact that each truck was constructed by three men in only three weeks, then painted and fitted up in three more weeks, and the cost for the entire construction, exclusive of the purchased tractor, was only slightly over $1000 per truck.

Welded Strips Replace Many Metal Stampings

When the welders were through with their work on a truck, it was as covered with the familiar blue areas as a leopard is with spots. Some of the most facile or artistic work that the welders had to do was the fashioning, out of strips, of such parts as are usually stamped from single sheets in big production. An example of this is the large splash guards over the rear wheels of the tractors, where sections of the flanges, which make double bends in two different directions from each other, were welded into place after the main sheets had been bent L-shaped. The finished jobs are as neat as any metal stampings have ever been.

While Deputy Chief Burke was engaged in this unusual municipal construction work, he also built the special chemical truck, which appears in the action photograph. The function of this is to furnish fire protection for the famous new Pulaski Skyway, an elevated thoroughfare, nearly 3½ miles long, which is without any water supply for combating automobile fires occurring in the heavy traffic it carries.

This 7-ton truck carries its own water supply of 600 gallons, and also foam-making equipment and 120 gallons of chemicals. A Barton centrifugal pump of 100 g.p.m. capacity at 200-lb. pressure is mounted on the left running board, just back of the driver's door. With a single 1½-in. hose, this pump can throw a stream 60 ft. high for 17 minutes before the tank is empty; but the pipe lines are also arranged so that three 1½-in. hoses, each 100 ft. long, may be used simultaneously for 11 minutes before emptying the tank.

Outworn Apparatus Salvaged Through Welding

The engine and chassis of this truck were donated by a public-service company. The rest of the equipment, excepting for the new Barton pump, was all salvaged from old fire apparatus that had outlived its usefulness. Of course new parts were made wherever needed; and oxyacetylene welding and cutting facilitated, in one way or another, the construction of nearly every detail of this special patrol which, before it was painted, looked as much like a blue-spotted leopard as did the hook-and-ladder trucks.

A "Home Made" Job.

(The fire department assembled this chemical truck largely from cast-off equipment that would otherwise have gone to the scrap heap. Oxyacetylene cutting and welding saved it for useful service in protecting property and lives.)

The welding outfits of the Jersey City Fire Department get almost continuous use because, out of necessity the department's shops are operated 24 hours a day, since they also handle all the work for the Police Department. This includes the making of patrol wagons and the servicing of radio patrol cars and motorcycles. Moreover, the city's ambulances are built and serviced by the Fire Department, including the specially designed, portable hospitals of metal construction, which are kept on location at all large outdoor gatherings, such as circuses and field-meets.

Oxyacetylene Cutting Used at Fire in 1912

After noting the extent of welding in construction work by only one fire department in just an average-size American city, it is historically interesting also to observe that the first recorded use of oxyacetylene equipment by any fire department occurred on the bitterly cold morning of January 9, 1912, during the famous Equitable Building fire in New York City. This fire, which was still having water poured into its ruins four days after it started, totally gutted in four hours an entire city block of "fireproof construction." The lessons learned from this misfortune were the most important single impetus accelerating the formulation of the Fire Underwriter's codes and conceptions of modern fireproof construction.

One hour after the start of the Equitable Building fire, the first cast-iron columns supporting the floors gave way, followed 35 minutes later by a general collapse, allowing enormous areas of nine different floors to fall through to the basement, thereby entrapping the guards who remained on duty at the vaults wherein one billion dollars of valuables were said to be stored. Two men were caught under a falling girder, and the only escape for the guards was prevented by hardened steel bars over windows, which the firemen tried quite futilely for over an hour to remove by methods which were primitive, indeed, compared to modern facilities.

But Eugene Bournonville, the welding pioneer, chanced to be nearby, where he was investigating some oxyacetylene work that was being done in connection with building reconstruction. So, with a cutting outfit and a helper, he rushed to the fire, only to discover that one fireman, working on the bars, had already been knocked out by falling bricks and mortar. However, Bournonville was in time to be able to cut away enough bars to liberate some of the unfortunate guards, though the intense heat make it impossible for him to enter the building far enough to burn out the metal doors which imprisoned several others, and through which there was no escape.

Gas Cutting Apparatus Now Standard Fire Equipment

As one of the results of the revelations in this calamity, John J. McElligott, the engineer who got "first water" on the Equitable fire, and who is now Fire Commissioner and Chief of the New York City Department, was detailed in 1915 as organizing captain to form New York's first rescue squad. In this work, then and ever since, oxy-

cetylene outfits have been among his most important tools—four squads so equipped being in service at the present time.

New York's cutting outfits have figured importantly at the few but serious subway accidents, and also at every important ship fire at the piers and in the harbor, where such a means is frequently the only method of being able to "open up" quickly enough to be able to get at the heart of the blaze in time to accomplish results before the plates of the ship are warped to a worthless condition.

Midwest Welding Conference in Chicago, June 4-6

For three days, June 4 to 6, the Midwest Welding Conference will hold forth at 2211 W. Pershing Road, Chicago, with talks by well-known authorities in the welding field, and practical demonstrations of d.c. and a.c. arc welding and oxyacetylene welding, on stainless steel, aluminum, cast iron and other metals, also brazing, hard-surfacing, railend welding, automatic flame cutting, thermit welding, metal spraying, and other actual operations, according to the Hollup Corp., who are sponsors of the conference, in cooperation with the American Brass Co., American Manganese Steel Co., American Steel & Wire Co., Burdett Oxygen & Hydrogen Co., Westinghouse Electric & Manufacturing Co., and *The Welding Engineer.*

Demonstrations will be in progress and exhibits open from 12 noon until 10 p. m. the first two days, and the last day from 10 a. m. to 10 p. m. The following program has been announced:

Thursday, June 4, 2 P. M.

Chairman: L. C. Monroe, advertising manager, *The Welding Engineer.*

"Arc Welding Costs Reduced by Cross-Field Principle," by J. H. Blankenbuehler, design engineer, Westinghouse Electric & Manufacturing Co.

"Recent Improvements in Shielded-Arc Welding and Its Application," by A. M. Candy, consulting engineer, Hollup Corp.

Discussion, led by W. W. Reddie, engineer, Westinghouse Electric & Manufacturing Co., and R. D. Long, metallurgist, Hollup Corp.

Friday, June 5, 2 P. M.

Chairman: R. R. Royal, Illinois Central R. R.

"Application of Electric Welding to the Railroads," by E. Wanamaker, electrical engineer, C. R. I. & P. R. R.

"Application of Bronze Welding and Brazing to Railroad Shops," by Homer Gannett, welding supervisor, C. B. & Q. R. R.

Discussion, led by A. M. Unger, welding engineer, Pullman-Standard Car Manufacturing Co., and J. P. Hocking, American Brass Co.

Friday, June 5, 8 P. M.

Chairman: R. C. Fischer, American Steel & Wire Co.

"New Developments in Steel Welding," by Thomas Jones, welding superintendent, Carnegie-Illinois Steel Co.

"Hard-Surfacing and Welding of Manganese Steel," by E. L. Quinn, welding engineer, American Manganese Steel Co.

"Welding Nickel, Monel Metal and Inconel," by F. G. Flocke, welding engineer, The International Nickel Co.

Discussion, led by Jonathan Wolfe, assistant superintendent of track and roadway, Chicago Surface Lines, and Chas. Young, Chicago manager, Metal & Thermit Corp.

Saturday, June 6, 11 A. M.

Chairman: Otto Voss, superintendent of plate shop, Allis-Chalmers Manufacturing Co.

"Welding of Class I Pressure Vessels" (speaker to be announced).

"Interesting New Developments in the Arc-Welding Industry," by W. W. Reddie, engineer, Westinghouse Electric & Manufacturing Co.

Discussion, led by H. C. Boardman, research engineer, Chicago Bridge & Iron Works.

Saturday, June 6, 2 P. M.

"The Control of Expansion and Contraction by Local Heating in Cast-Iron Parts," by Roy Peterson, bronze-welding engineer, Burdett Oxygen & Hydrogen Co.

"Automatic Shape Cutting" (speaker to be announced).

"Phos-Copper," by E. A. Randall, service engineer, Burdett Oxygen & Hydrogen Co.

News of Welded Pipelines

Contracts for a 79-mile welded pipeline to be laid in western Kansas, have been awarded the Williams Brothers Construction Co. by the Continental Oil Co. The sub-contract for welding has been awarded to the Osage Construction Co. Sixty-five miles of the line will be 8-in. and 14 miles will be 6-in. pipe, it is reported. Pipe will be furnished in 40-ft. lengths.

A natural-gas pipeline is to be laid between Terre Haute and Montezuma, Ind., by Connor & Sons Construction Co., of Kansas City, Mo., for the Kentucky Natural Gas Corp. There will be 24 miles of 12-in. pipe in 20-ft. random lengths.

The Indiana line as well as the western Kansas line is to be welded by the Lindeweld multi-flame process, says an announcement from The Linde Air Products Co., New York, N. Y.

* * *

The Pure Oil Co. and the Gulf Refining Co. are planning the early construction of a 150-mile welded gasoline pipeline to extend from Port Birmingham to Atlanta, Ga. The size of the line has not been announced.

* * *

Work is to start at once on the launching of a crude-oil welded pipeline project on the Pacific coast to cost $4,500,000, it was announced a short time ago by the Shell Oil Co. The line will reach from fields adjacent to Bakersfield, Calif., to the company's refinery at Martinez. The line will have a carrying capacity of 25,000 barrels, and will range in size from 6 to 12 in. The entire line will be 305 miles long. Ninety miles will reach from Bakersfield to Caliola, a pumping station near Coalinga, and there will be 44 miles of 12-in. gathering lines adjacent to Bakersfield. Additional construction which will require a considerable amount of welding will be the erection of pumping plants and installation of equipment along the line from Mountain View to Caliola.

* * *

The Phillips Petroleum Co. is laying 40 miles of welded pipeline in New Mexico. The line, which will range in size from 2½ to 12 in., will run from Hobbs to the White Deer pipeline. About 33 miles of the line is oxyacetylene welded.

Completes Welding of Spherical Holder

Finishing touches are now being put to the 200,000-cu ft. spherical gas-holder which is being erected at the plant of the Diamond Alkali Co., Fairport Harbor, Ohio, by the Bethlehem Steel Co., of Pittsburgh, Pa., preliminary details of which appeared in the April issue of *The Welding Engineer.*

The sphere, which is to be used for the storage of coke-oven gas, is 55 ft. in diameter and weighs 155 tons. It is being constructed and butt welded under the Rules for Construction of Unfired Pressure Vessels of the State of Ohio. It will have a working pressure of 50 lb. per sq. in.

This huge holder was fabricated at the Leetsdale, Pa., works of the Bethlehem company and shipped "knocked down" to destination, where it is being erected under the supervision of Bethlehem engineers. A shop coat of lead paint has been applied and, when finished, the outside of the sphere will be painted with a coat of aluminum.

Advance Reservations Set New Record

On April 30, 85% of the exhibit space in the huge underground exhibit hall of Cleveland's Public Auditorium had been contracted for by exhibitors in the 18th annual National Metal Show, to be held Oct. 19 to 23.

"Reservations are 21% ahead of 1928, which had set a high mark for advance reservations," says W. H. Eisenman, managing director of the show. "Steps are already being taken to obtain additional exhibit space, and it is likely that the 1936 show will be far larger than any of the previous ones."

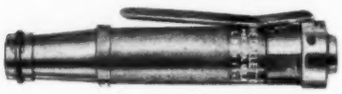
Aluminum would still be a rare metal if electricity could not be produced at a low cost, for from 10 to 12 kilowatt hours are required to make each pound of the light metal.

What's New in Equipment and Supplies

Dallett Company Puts Flux Scaler on Market

The Dallett Weld Flux-Scaler for chipping and cleaning welds has been placed on the market by The Dallett Co., Hancock & Lippincott Sts., Philadelphia, Pa. This pneumatic tool weighs but 2 lb., can be attached to the air line, and consumes only 5 cu. ft. per minute at 60 lb. pressure.

Complete chisel equipment is provided for the rapid removing of weld flux and



Hand Tool and Chisels.
(This compact outfit insures fast, clean work with economy in time and expense.)

for light scraping, caulking, etc. The use of this equipment is said to result in faster, cleaner work, with resultant substantial savings in time and money.

"Supero Siameez" Is New Twin Hose for Welding

A type of rubber tubing, or hose, of radically new construction, which can be used with gas welding or cutting equipment, consists of twin hose simultaneously molded with a connecting web between them, so that a cross-section resembles the figure 8. "Supero Siameez" is the trade-name adopted for this hose by the manufacturers, the Electric Hose & Rubber Co., Wilmington, Dela. A single length of this non-kinking hose is

Won't Kink, Tangle or Twist.
(The construction prevents kinking. Special reenforcement provides a 2,000 lb. per sq. in. bursting point.)

all that is necessary for equipment which heretofore has required two separate lengths. This hose is of "Supero" construction, with a special cord-wound reinforcement between the first and second braid, which is said to give it a very high burst limit. With the ¼-in. size, the burst is 2,000 lb. per sq. in. The construction permits the use of different pressures in each side without torque or writhing.

"Supero Siameez" hose is made with individual hose in different colors—red and black or red and green, for example —or with both hose lines the same color. The connecting web may be cut down with a carborundum wheel the distance required for attaching the hose to separate outlets.

Aligner for Heavy Motor Vehicles Announced

A heavy-duty aligner capable of servicing busses, trucks, trailers and passenger cars has been placed on the market by the Bee Line Manufacturing Co., of Davenport, Ia.

The unit is equipped with turning aligning gauges that are devised so that all tires are accurately centered and gauged. The turning aligning gauge clamps will grip from 3½ to 12½ in. tires. Center-to-center distance of the turning aligners is adjustable from 52 to 78 in. tread.

The runways are sectional type and can be lowered so as to permit accessibility to any part of the chassis. They are also adjustable to accommodate different tread widths.

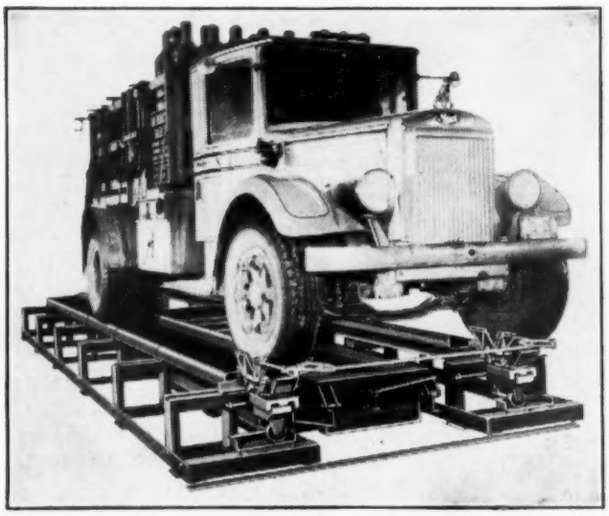
The hydraulic press provided for straightening operations is an independent unit. The press beams are equipped with 8 in. H-beam members. A large safety factor has been allowed. Four cross beams are used for side bends. These beams are full roller mounted for easy movement in all directions and have such low fractional losses that heavy work can be handled with smaller jacks than are required with any other type of construction, it is claimed.

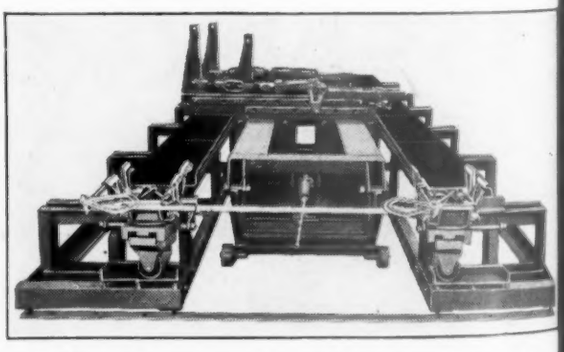
The use of high-strength alloy steel for many parts and attachments results in lightness in material and, at the same time, high reserve strength.

Modern Engineering Co. Has Extra-Light-Weight Torch

A welding torch that is said to set a new record in light weight, has been announced by the Modern Engineering Co., St. Louis, Mo., and is known as the Meco Weldmaster torch. This torch, with a standard tip, weighs only 17½ oz., and a recently developed high-strength alloy is used in its construction. The torch is said to be perfectly balanced by reason of weight elimination and is highly flexible and not tiring to the operator.

The circle mixer used in all Meco torches has been improved and its capacity increased, and this device has been incorporated into this torch. Even the largest tips may be used efficiently with low gas pressures, it is claimed, and





ABOVE—Framework of Heavy Duty Automotive Aligner.
(The turning aligning gauge will grip from 3½ to 12½ in. tires.)

LEFT—A Heavy Motor Truck in Place.
(Runways are sectional type, and can be lowered or raised. They can also be adjusted for different tread widths.)

Mr. C. G. Blackwell, Tobin Bronze enthusiast, and his Dayton Welding Co. shop.

Dayton Welding Company
GAS AND ELECTRIC WELDING
13 S. ST. CLAIR STREET
DAYTON, OHIO

June 6 1935

The American Brass Company
Waterbury, Connecticut

Gentlemen:

"To say I'm sold on Tobin Bronze is putting it mildly. For more than 20 years, I have used this welding rod...and today all of us prefer it to any other. Why? Because Tobin Bronze is more economical to use and helps my men make better, more dependable welds.

C. G. Blackwell

Welding a Lion's Tail with Tobin Bronze

During the Dayton flood in 1913, this monument was washed from its base and the lion's tail was broken off. With Tobin Bronze Mr. Blackwell welded the broken part, which weighed 75 pounds, to the main statue. Today . . . 22 years later . . . the weld is still sound. Tobin Bronze makes tough bonds!

Why this Ohio Welder uses Tobin Bronze *exclusively*

MELTING POINTS OF ANACONDA WELDING RODS		
Material	Approximate Melting Point Degrees	
	Cent.	Fahr.
Tobin Bronze*	885	1625
Manganese Bronze	870	1598
Brazing Metal	930	1706
Economy Bronze*	885	1625
Everdur*	1019	1866
Anaconda 520	885	1625
Phosphor Bronze A	1050	1922
Phosphor Bronze E	1070	1958
Phosphor Bronze D	1000	1830
Phosphor Bronze C	1025	1877
Silicon Copper	1083	1981
Deoxidized Copper	1083	1981
Electrolytic Copper	1083	1981
Nickel Silver	1055	1931
Ambrac*	1150	2102

*Trade-marks Reg. U. S. Pat. Off.

THROUGHOUT his long experience in the welding business, Mr. C. G. Blackwell has done many unusual jobs with Tobin Bronze. Invariably the work has been satisfactory—a very good reason why Mr. Blackwell will use no other rod.

Thousands of experienced welders will accept no substitute for Tobin Bronze when it comes to the general oxy-acetylene welding of cast and malleable iron . . . locomotive cylinders, automobile engine blocks, cast iron pipes, machinery parts and similar equipment.

Time-tried Tobin Bronze carries the name stamped every 12 inches in each rod. So, when you ask for "Tobin", look for this mark and make sure you are getting the genuine product.

ANACONDA

THE AMERICAN BRASS COMPANY

General Offices: Waterbury, Connecticut

Offices and Agencies in Principal Cities

In Canada: ANACONDA AMERICAN BRASS LIMITED, NEW TORONTO, ONTARIO

ANACONDA WELDING RODS

Extra-Light-Weight Torch.
(This is the new Meco Weldmaster, which with a standard tip weighs only 17½ oz. Its many interesting features are described in the accompanying text.)

ideal flame characteristics are said to be obtained under any set of operating conditions in the full range of welding practice. A new method for boring the gas passages gives them a rifle smoothness.

There are also other features, such as wheel handles equipped with spring tension, assuring permanent adjustments, and a thin grip with wide fluting. The grip is an electrically applied blue finish, with a contrasting silvery-type alloy over the rest of the handle.

New Rods for Manganese Steel and Hard Surfacing

Welding rods for manganese-steel welding and hard-surfacing have been announced by the Machinery and Welder Corp., 240 S. Boyle Ave., St. Louis, Mo.

The hard-surfacing rods are known as M-W Hardsurfs No. 1 and No. 2. They can be applied by either the arc or oxyacetylene process, and are recommended for application to manganese steel, low-carbon steel, and other ferrous metals. If the part has to be built up to a considerable depth, a manganese rod should be used for the first layers, and then a final coat given of one of the Hardsurf rods.

These rods have an iron base, and when it is necessary to heat-treat the welded part after surfacing, the weld is not affected in either adhesion or hardness, it is claimed.

Deposits made with the No. 1 rod have a high resistance to abrasion, chipping and spalling, and a high degree of toughness. The Brinell hardness is between 500 and 600. If temperatures in excess of 500°F. are maintained, the No. 2 rod should be used.

Hardsurf No. 2 is essentially the same in basic analysis as No. 1, but contains a high percentage of tungsten, thus increasing the Brinell hardness to 600 to 700, and retaining its wear-hardness up to 1000°F.

The Hardsurf rods are supplied bare for gas welding and coated for arc welding. They can be had in diameters of 3/16, 1/4 and 5/16 in.

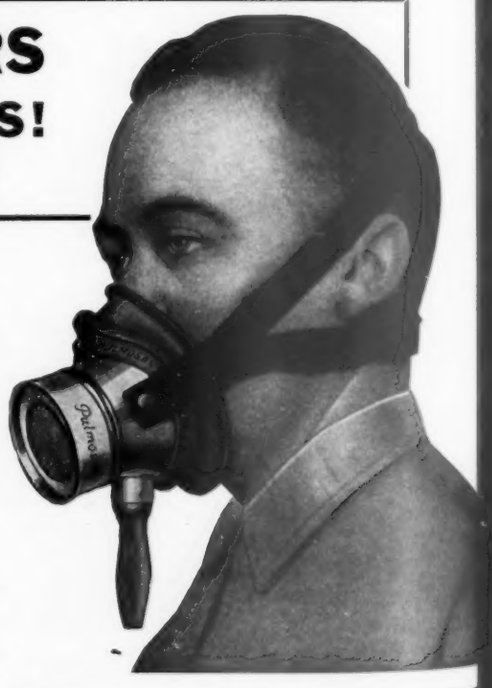
The new rod for manganese-steel welding is known as M-W Nieman, and contains an addition of nickel, thus inhibiting embrittlement of the weld under slow cooling and requiring no quenching. It is said to be ideal for building up manganese steel, carbon steel, grey iron and chilled iron, or as a backing for hard-facing deposits. It is supplied bare or coated for d.c. welding (reverse polarity) and as a coated rod for a.c. application.

Insulated Holder Has New Features of Design

At least 90% of the flashes that welders get are caused by contacting the ordinary bare-type electrode holder with grounded parts. To eliminate such flashes, to provide a maximum degree of safety for the operator and protection for the work, and to provide long and economical holder service, the Jackson Electrode Holder Co., 6553 Woodward Ave., Detroit, Mich., is introducing a new model embodying radical improvements in design.

The new holder, like previous Jackson holders, is completely insulated, air circulation being provided between insulation and metal to achieve coolness.

PROTECT *your* WELDERS
AGAINST DANGEROUS FUMES!
Supply this respirator with their goggles!



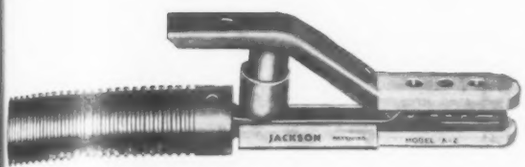
Not only welders' eyes, but also their lungs need protection when working in badly ventilated rooms—in confined places such as tanks — or on any metals coated with paint or substances. These fumes are injurious to health. Avoid all danger with the

R-150 CHEMICAL CARTRIDGE RESPIRATOR

which purifies inhaled air. A special chemical cartridge makes noxious fumes harmless. The R-150 is safe, comfortable, light weight, permits easy breathing. Inexpensive. No hindrance to goggles or working efficiency. Thousands in use. Send order today, or write for further details.

PULMOSAN SAFETY EQUIPMENT CORP.
Dept. W. E., 176 Johnson St., Brooklyn, N. Y.

Also full line of
GOGGLES **HELMETS**
GLOVES **ELECTRODE HOLDERS**
Write for complete catalog.



Completely Insulated.
(The weight, however, is no greater than that of bare-type holders of comparable capacity.)

spite of the insulation, the total weight of the new holder is about that of bare-type holders of comparable capacity, it is claimed. A special copper alloy has been adopted for the structural parts of the holder, combining strength with high conductivity.

This new holder is provided with replaceable jaws of Mallory 3 metal, a copper alloy that is already widely used for spot-welding tips, flash-welding dies and seam-welding wheels. It combines the tensile and elastic properties of structural steel with the high electrical conductivity and corrosion resistance of pure copper. This jaw construction has unusually long life and, when the jaws ultimately do become worn, replacement is simple, easy and economical, adding indefinitely to the life of the holder.

New Welding Generator for Belted or Coupled Sets

Based on the cross-field principle of the FlexArc Welder, a new welding generator for belted or coupled welding sets, with a novel control system producing high arc quality and eliminating rheostat, resistors, meter, reactor and exciter, is announced by the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. That the welding current is unaffected by the ordinary speed variations of the driving unit, is claimed as a result of the design.

Rated at 200, 300 and 400 amperes, this new generator has a novel system of control which allows the operator to adjust for the welding current required before the set is started, thus eliminating the trial-and-error methods usually used. This control is continuous, without steps, and permits minute changes in current adjustment. A polarity-reversing switch is provided.

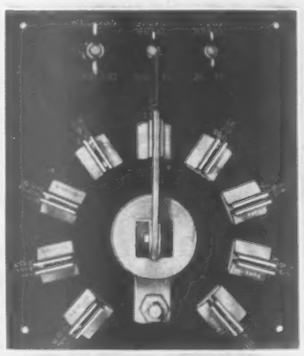
Elimination of the exciter makes it possible to use an exceptionally short and heavy shaft, which greatly minimizes possibility of vibration. The shaft runs on ball bearings, which have a new and unusually effective seal.

The generator is enclosed in a rugged shell of drip-proof construction with four solid machined feet. Two ball bearings are provided, one at either end. A drip cover over the commutator is removable to permit access to the brushes.

Generator for Portability.

A.C. Amperages Controlled By One Switch

Due to the confusion and complications of the various controls used with a. c. welders, The Miller Electric Manufacturing Co. has perfected a rotary-knife-switch control which brings all the amperage changes under one switch arrangement. The control is distinctly marked in amperes, so the operator knows exactly what amperage he is getting under any setting of the switch. It is of heavy-duty construction, which assures long life and trouble-free operation. Contact between knife blade and the welding lead is made through a large copper disc of heavy carrying capacity. The switch can be rotated in either direction.



Eliminates Confusion and Complications.

With the announcement of this improvement to the Miller Wonder Arc Welder, the manufacturer states that the entire sales of these welders is now being handled by the Giant Grip Manufacturing Co., Oshkosh, Wis. The merger of these two organizations results in a set-up that puts behind this item a national sales force that will be able to better service the jobbers and users.

Obtains Independent Control With A.C. Ring System

A means for the independent regulation of welding current and voltage from the a.c. multiple or ring system has been announced by C. J. Holslag, of the Electric Arc Cutting & Welding Co., Newark, N. J., who states that each operator can regulate his voltage and

RYERSON

A Dependable Source for

WELDING ROD

Ryerson Engineers have developed a series of rods that are outstanding for quality production. They are continually checking, testing, and improving—to develop rods that will do specific types of work, faster and better.

Bring your welding rod problem to Ryerson. Let our engineers work with you. You can be sure of finding the right rod for each particular class of work. We will also gladly furnish samples for test. Address the nearest Ryerson plant.

23 Types of Rods in Stock

ELECTRODES

Ryerson Shielded Arc Type No. 215
Ryerson Shielded Arc Type No. 216
Ryerson Shielded Arc Type No. 217
Ryerson Green Processed No. 18
Ryerson Green Processed No. 6
Ryerson Bare Mild Steel
Ryerson Brown Processed
Ryerson White Flux Coated
Ryerson High Carbon White Flux Coated
Ryerson Blue Flux Coated
Ryerson 3½% Nickel Steel Flux Coated
Ryerson High Manganese Steel
Hyerson Hard Surfacing
Ryerson Allegheny Stainless Flux Coated
Ryerson Allegheny Stainless No. 44

GAS RODS

Ryerson Copper Coated No. 206
Ryerson Copper Coated No. 210
Ryerson Cast Iron
Ryerson 3½% Nickel Steel
Ryerson Tobin Bronze
Ryerson High Carbon Bare No. 2110
Ryerson Allegheny Stainless Bare
Ryerson Hard Filler

Write for Bulletin on Rods and Accessories

JOSEPH T. RYERSON & SON, Inc.

Chicago, Milwaukee, St. Louis, Cincinnati, Detroit, Cleveland, Buffalo
Boston, Philadelphia, Jersey City.

current independently of the others and can compensate for line drop in either direction—that is, above the line voltage or below. In the multiple a.c. system, high efficiency is claimed by making a ring circuit around the shop walls with reactor controls taken from the line. Floor space is not taken up with individual welding units and the welding leads need be only long enough to hook onto the nearest point of the "ring." Other advantages claimed are low first cost and high economy in operation.

New Flux Promotes Easy Welding of Cast Iron

A new flux for use in the welding of cast iron with bronze or cast-iron rods has been placed on the market by the Northeast Metals Co., 4124 Torresdale Ave., Philadelphia, Pa., and goes under the trade name of Nemco Flux. This flux is said to result in unusually swift chemical action, thereby effecting a substantial reduction in the time required in welding cast iron, and this is translated into savings in labor and gases. Dirt, scale and oxide are removed by action of this flux, and strong, clean welds are said to be obtained, even though the weld metal be overheated to the extent of 500° F. Nemco Flux is packed in 1-lb. cans, and free samples are offered.

Eisler Announces Line of A.C. Welding Units

A new line of a.c. arc-welding units, compactly designed and portable, has been announced by the Eisler Engineering Co., Inc., 749 South 13th St., Newark, N. J. These are supplied in two sizes, one rated at 40 to 200 amperes and the other at 50 to 300 amperes, both sizes having 11-point controls. The smaller size takes 1/16 to 3/16-in. electrodes and the larger size will handle 3/32- to ¼-in. electrodes. This company recently added a fully equipped transformer division and is said to be able to produce any size and type of transformer. A weld-testing department is also maintained.

Trade Literature

"Welding and Cutting High Chromium Steels" is the title of a booklet issued by The Linde Air Products Co., of New York City. Among the topics taken up in detail are: The effect of chromium on welding procedures, techniques for welding various types of high-chromium steels, improved welding characteristics obtained by additions of columbium to both base metal and welding rod, oxyacetylene cutting of high-chromium steel, as well as various techniques for this process.

"Fabrication and Treatment of USS Stainless and Heat-Resisting Steels" is the title of a 42-page book issued by Peter A. Frasse & Co., Inc., 17 Grand St., New York, N. Y. Information is given on welding by the various processes, finishing of stainless-steel welds, soldering, silver soldering, riveting, annealing, pickling, sand-blasting, machining and cutting operations, drawing and forming, spinning, fabrication and treatment of tubes, and finishing of fabricated articles.

The fourth edition of "Toncan Iron for Permanence" is being distributed by the Republic Steel Corp., Cleveland, Ohio. This 64-page book is illustrated with test charts and tables, and incorporates new sections dealing with threading, air conditioning, industrial maintenance and process uses, and brewing and distilling applications. Many applications are illustrated.

Catalog and Price List No. 107 has been issued by Tube-Turns, Inc., of Louisville, Ky., makers of welding fittings, containing much valuable data not only on elbows, tees, flanges, reducers, etc., but also upon the advantages of welding fittings over threaded, bolted or screwed fittings. The booklet contains many striking illustrations of welding-fitting installations.

"Facts for Users of A. C. Motors" is the title of a folder issued by The Lincoln Electric Co., Cleveland, Ohio, giving ratings, prices, size of wire for connecting to the line, dimensions, weights, and a table of electrical data.

The handling of tin plate and sheets on special lift trucks, floor trucks, portable elevators, stackers, etc., is illustrated and described in circulars No. 302 and 314, published by the Lewis-Shepard Co., Watertown, Mass.

A most interesting booklet describing Manganal applicator bars, welding electrodes, forged wedges and wedge bars has been issued by the Stulz-Sickles Co., 91 N. J. Railroad Ave., Newark, N. J.

Truck and trailer size and weight restrictions imposed by the various states of the Union are listed in the 1936 edition of a manual issued by The Four Wheel Drive Auto Co., Clintonville, Wis.

Instructions for grinding lathe-tool cutter bits, and for cutting screw threads, are given in Bulletins Nos. 35 and 36A, respectively, recently published by the South Bend Lathe Works, South Bend, Ind.

Keystone electrode holders are described in a new circular issued by F. R. Faulk, 50 Penn Ave., Pittsburgh, Pa., distributor.

Commercial News

Torchweld Adds Truck to Improve Delivery

To improve their local delivery service to customers in and near Chicago, the Torchweld Equipment Co., 1035 W. Lake St., Chicago, have added the first delivery truck which the company has ever maintained. Previously all local deliveries were made in salesmen's cars.

Addition of the delivery truck has been made necessary, according to "Jerry" Jensen, general manager of the Torchweld organization, by reason of a 100% pickup in the firm's business during the first quarter of 1936 over a similar period last year. At the end of the first quarter the company declared a dividend of $2 per share on its stock.

"It is a significant fact," explained Mr. Jensen, "that many old customers

More and Better Service.
(Increased business has necessitated the addition of this delivery truck by the Torchweld Equipment Co. of Chicago.)

(Trade Mark Registered)

Welds made with

PENN*

doubly deoxidized

Bronze Welding Rods

*U. S. Patent Number 2,022,439

possess

Greater Strength

combined with

Greater Ductility

due to the exclusive Double Deoxidation feature, found only in Titan alloys.

Additional features of Penn Bronze and other Titan Welding Alloys that cause them to be preferred by welders everywhere include:

Uniform Tinning
Low Melting
Low Fuming
Corrosion Resistance

●

Samples and literature describing our Penn Bronze, Titan Bronze, Titan Brazing Bronze and Titan Manganese Bronze Alloys sent on request. No obligation.

TITAN METAL MFG. CO.
Bellefonte, Pa.

THE MARK OF SERVICE

CUSTOMERS

A railroad, famed for sound sleeping passengers, orders a Caterpillar Mounted Arc Welder to build up worn, sleep-destroying frogs, switches and crossings.

A contractor establishes a nearby M-W Warehouse as his master store-room and draws upon it for a half dozen G. E. Heavy Duty Arc Welders to weld together a bridge that will weld two cities together.

Industrial plants call in M-W Engineers, have their welding processes analyzed—recommendations made—and into production lines go multiple units of standard and special, M-W supplied, arc and resistance Welders, and torches. Production is accelerated, costs are cut and a superior finished product is achieved.

In machine shops, welding shops, auto repairshops—everywhere in the wide field of the welding industry you will find customers of the Machinery and Welder Corporation—from internationally renowned organizations to neighborhood operators. All have found M-W a reliable source of supply.

Regardless of the extent of your welding activity, you, too, will find equipment, supplies and competent engineering service always available at your M-W Warehouse.

ST. LOUIS
240 S. Boyle
CHICAGO
312 N. Sheldon
MILWAUKEE
2118 W. National
MOLINE
729 E. Third
KANSAS CITY
1705 Baltimore

ELECTRIC ARC • RESISTANCE • ACETYLENE • WELDING EQUIPMENT

Electrode Holders
Arc Welding Cables
Cable Connectors
Helmets
Handshields
Goggles
Respirators
Protective Glasses
Protective Clothing
Aprons, Gloves, Spats, Sleeves, Leggings.
Welding Hose and Connections.
Torch Lighters, Meters, Gauges.
Acetylene Generators.

MACHINERY AND WELDER CORPORATION

WE RENT WELDING EQUIPMENT

whose accounts on our books had been dormant for the past few years have become exceedingly active in the last few months."

The Torchweld company has added Premier rods to their line and has also added a brazing rod known as the Torchweld Free Flowing rod.

Davidson Heads Chicago Branch of K. O. Lee & Son Co.

R. A. Davidson, prominently identified with the welding industry in the Middle West for more than ten years, has been appointed branch manager for the K. O. Lee & Son Co., of Aberdeen, S. D., manufacturers of a.c. welders and of tools for the automotive industry, and has charge of the Chicago branch, with offices at 337 S. Western Ave. Mr. Davidson for several years served as Chicago district sales manager for The Lincoln Electric Co., was for a time in charge of machinery sales for Joseph T. Ryerson & Sons, in the Southwest territory, with headquarters at St. Louis, and was more recently general sales manager of the Hollup Corp., of Chicago.

The Lincoln Electric Co., Cleveland, Ohio, report the following changes in their sales force: J. S. McKeighan has been transferred to the Cincinnati district, and is stationed at 1712 Catalpa Drive, Dayton, Ohio. J. B. McCormick has been transferred from the Philadelphia office and is now stationed at 3160 Montecito Ave., Fresno, Calif., under the jurisdiction of the Los Angeles office. Paul W. Jones has been transferred from the factory to 16½ Crandall St., Binghamton, N. Y., operating under the Syracuse office.

L. L. Caskey has been appointed district sales manager for the Republic Steel Corp. in the Philadelphia territory. J. B. DeWolfe, whom Mr. Caskey succeeds, has been transferred to the general offices of the company, in Cleveland, as assistant to George E. Totten, manager of sales of the tin-plate division.

Benjamin B. Gracier has been appointed factory manager of the road-machinery plant of the Caterpillar Tractor Co. at Peoria, Ill. Mr. Gracier has been identified with this company and with one of its predecessors, the C. L. Best Tractor Co., for nearly twenty years.

Good attendance and high interest marked a series of educational welding programs held by The Balbach Co., Omaha, Nebr., in the following localities: Wausa, Nebr., Apr. 6; Carroll, Ia., Apr. 21; Boone, Ia., Apr. 23, and Shenandoah, Ia., Apr. 30.

In the two years since the first edition was published, almost 20,000 copies of their book, "Procedure Handbook of Arc Welding Design and Practice," have been sold, reports The Lincoln Electric Co., Cleveland, Ohio.

Oliver W. Morton, purchasing agent for the American Hoist & Derrick Co., St. Paul, Minn., has resigned after 36 years' service with that company. He is succeeded by R. T. Reilly.

The New York district sales office of the Republic Steel Corp. has opened a new sub-office in the State Bank Building in Albany, with J. M. Higginbotham as salesman in charge.

The Major Engineering Works, Des Moines, Iowa, has moved its offices from 210 Jackson Ave. to larger and more conveniently located quarters at 312 Second St.

Notes From the Field

An order for 100 cars to be used in the 8th Avenue Subway, New York City, is being completed by the Pressed Steel Car Co., McKees Rocks, Pa. Welding played an important part in the construction of these cars, and the fabricators report an increasing demand for welded equipment. The Pressed Steel Car Co. plant was badly inundated by the great St. Patrick's Day flood, but the machinery and equipment has been rehabilitated and the plant is now working on a normal basis.

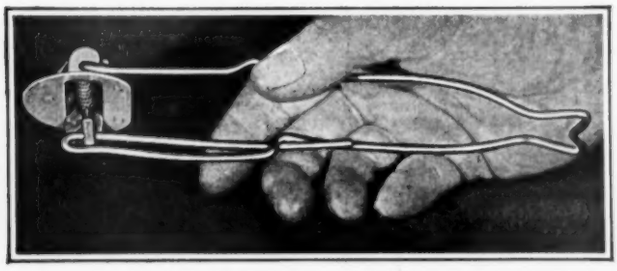
The Dravo Contracting Co., of Pittsburgh, Pa., are doing a lot of miscellaneous welding repair work on their marine ways at Neville Island, a few miles below Pittsburgh. Included are welded brackets, rope-guards, tow-guards and fittings for a steamer for the Campbell Transportation Co., of Pittsburgh, and repairs of a steel hull derrick-boat for the United States Army Engineers in the Pittsburgh district.

During the recent flood in Hartford, Conn., seven welding machines were furnished by The State Welding Co., of Hartford, for various purposes, these including three machines for the Hotel Bond, six at the Neuro-Psychiatric Institute, two 10-kw. a.c. generators for the Connecticut General Insurance Co., two for the telephone company, and one for the Hygrade Oil Co.

To complete the construction of a steel runway at The American Distillery in Pekin, Ill., it will be necessary to move a million-gallon tank several feet from its present location. The runway will have an all-welded turntable and the posts supporting the handrail, which is finished, are welded. Welding is also used on their new rackhouse, which has just been completed.

A new school building at Dunlap, Ill., erected by PWA, is of steel construction with a sheet-metal roof which is tack-welded to the roof trusses and purlins. Another one at Chillicothe, Ill., is nearing completion and has about 90,000

The Improved "Round File" Gas Lighter



Many superior design and construction features, found only in Improved "Round File," make this lighter the Welder's Favorite.

Hood forms a pocket for gas, insuring immediate ignition.
Larger file area, providing longer life for lighter.
Larger spark metal, which assures many additional ignitions.
Locking slip-on renewal cartridge, permits immediate replacement.
Cadmium plated, preventing rust.
Every part **thoroughly tested.**
Fully guaranteed.

Write for descriptive circulars and prices.

CAUTION: Imitations of the patented Improved "Round File" are on the market. For your protection insist on Safety Gas Lighter Co. patented lighters and genuine Safety Gas Lighter Co. renewals.

ORIGINATORS OF THE HAND GAS LIGHTERS **SAFETY GAS LIGHTER CO.** Est. 1901 **LYNN, MASS.**

New Torchweld Cutting Unit Complete for Only $65!

"You Can Do It Better With Torchweld"

The new 16SL TORCHWELD cutting unit illustrated above is designed for production and general cutting, and can be depended upon for unsurpassed service under all circumstances. Constructed with the well-known TORCHWELD patented non-flash chamber, full protection against flashbacks is assured. Torch and tips only, $25.

Write today for new catalog describing complete line of cutting and welding torches.

TORCHWELD EQUIPMENT CO.
335 WEST LAKE STREET CHICAGO, ILLINOIS

DON'T WELD ANOTHER PIECE OF STEEL!

...until
...u've
...tained a **BRIGHTBOY No. 88 "TABLET"**
...o remove heat marks on stainless steel

BRIGHTBOY is a light abrasive, incorporated in soft rubber, in convenient "tablet" form, in bias shape. $2\frac{3}{16}$" long — $1\frac{1}{8}$" wide and $\frac{3}{8}$" thick. Double size, handier and more economical, $\frac{3}{4}$" thick.

The soft Rubber Binder cushions the abrasive.

Manufactured by
...ELDON ROBERTS RUBBER CO., Newark, N. J.

ARC-WELDERS ADAMS ELECTRODES

Adams Vertical Arc Welders and Fillet-Craft Electrodes are used by Insley Manufacturing Company, Indianapolis, for a variety of welding work.

TRY "FILLET-CRAFT" ELECTRODES—

For ASME code welding or heavy fabrication which must withstand heavy shock or impact stresses, try Adams Fillet-Craft Electrodes. They are heavily mineral-coated, used with straight polarity and produce smooth, flat fillet welds of high quality at high speed without spatter or under-cutting. Fusion metal shows an ultimate tensile strength averaging 75,000 lbs. per square inch.

A Complete Arc Welding Service

The Adams line includes many other types of electrodes —mineral coated, processed and bare—and a complete line of arc welding equipment including Motor-Driven Welders (AC and DC), Engine-Driven Welders, Automatic Welding Heads, and a complete line of accessories. . . . There is an Adams welding engineer near you, who is prepared to give you a valuable advisory service without cost or obligation. A letter briefly outlining your welding job will place him at your service.

J. D. ADAMS COMPANY
INDIANAPOLIS, INDIANA
Offices in Principal Cities

TOOLS FOR PRODUCING BETTER FUSION METAL

sq. ft. of sheet-metal roofing to be tack welded. Contract for the welding has not yet been awarded.

Bids for the construction of 33 all-welded steel storage tanks for use in connection with a plant-expansion program, are being taken by the Cumberland Brewery Co., Cumberland, W. Va. The tanks will require in the neighborhood of 200 tons of steel. The tanks will be 10 ft. in diameter, with lengths varying from 11 to 36 ft.

A fire caused by a gasoline explosion recently destroyed "Jack's Welding Shop" at 6910½ South Central Ave., in Los Angeles. The shop is being reopened at a nearby location, at Hooper and Florence Aves.

The Tri-State Transportation Co., Morgantown, W. Va., are reported as being in the market for three oil tank barges of welded construction. The company operates a fleet of carriers from Morgantown to Pittsburgh.

A welding club was recently organized at Ashland, Ky. It's called the "Triangle Welders Club."

· CLASSIFIED ADS ·

Help Wanted—75c per line, minimum 4 lines. Jobs Wanted—4 lines free. Other Ads—$1.00 per line, minimum 4 lines. Count 8 words to line. Add 6 words for keyed address.

FOR SALE

EXCESS NEW STOCK—GUARANTEED

3 metal-spray guns, $175 each; 6 a.c. arc welders, $75 each; 1840 ft. super-flexible cable; 115 electrode holders; 97 helmets; 212 hand shields; 277 lenses; 4925 lb. shielded-arc electrodes; 35 welding torches; 22 cutting torches. Address May-5, The Welding Engineer.

Welders—Three 300-ampere Lincoln, engine-driven; three 200-ampere Lincoln, engine-driven; four 220/440-volt, 200 and 300-400 ampere Lincoln, engine-driven. Other bargains. Service Co., 3741 Cedar Ave., Cleveland, Ohio.

Fly Ball Governors—Adapted to all makes of auto engines; belt driven, flat or V. Price, $6.50 prepaid. Satisfaction guaranteed. In ordering state style of belt. Wm. D. Alber, Beatrice, Nebr.

Bargains—Demonstrator Arc Welders. Gasoline and electric drive. 30 days' trial. Easy terms if desired. Write Ken's Exchange, Box U-561, Troy, Ohio.

For Sale—New 200-ampere Hobart motor-generator set, complete with gas engine, portable, $400. M. J. MacSwain, Y. M. C. A., Eau Claire, Wisconsin.

POSITIONS WANTED

Civil Engineer—Technical graduate in civil engineering desires position in the welding field as an engineer, inspector or foreman. Experience includes design and detailing in office, foreman and instructor in shop. Both arc and gas welding. Age 31 years. Address May-1, The Welding Engineer.

Welder—18 years' experience in electric and oxyacetylene welding. Have supervised job welding shops. 38 years old. Willing to go any place. M. J. MacSwain, Y. M. C. A., Eau Claire, Wis.

HELP WANTED

Sales Manager—Man who has had practical electrical welding experience, who would like to make a salary of at least $10,000 per year acting in capacity of sales manager. Apply in writing, giving full details. Address May-2, The Welding Engineer.

Coated-Electrode Expert—Experienced in the manufacture of coated electrodes. Willing to work outside of United States. State qualifications and salary expected first letter. Must be ready to leave at an early date. Address May-3, The Welding Engineer.

Salesmen, Distributors and Dealers—To sell a patented welding electrode for repairing and rebuilding manganese-steel shovel teeth, crushers, etc. Very attractive proposition. Address May-4, The Welding Engineer.

MISCELLANEOUS

$25.00 Reward—For information leading to the location of Arthur F. Warren of the Allied Electric Co., Falconer, N. Y., or the location of the 500-ampere, 220-volt d.c. welding machine he took from the Jamestown, N. Y., freight station March 31. C. J. Holslag, Electric Arc Cutting & Welding Co., Newark, N. J.

Repairing—All makes of oxyacetylene welding and cutting equipment. Don't scrap old torches or regulators. I can make them work like new. Twenty years' experience. J. M. Shevlin, P. O. Box No. 51, Reading, Pa.

Arc Welders—Build Your Own, saving $300 to $500. Complete instructions furnished. Easy pays-its-own-way terms. Investigate before you buy any welder. Hobart Welder Sales, Box U-462, Troy, Ohio.

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This is the only method whereby welding shops can successfully weld plow shares without previous plow experience and without the forge fire. The New Process patented method makes this highly satisfactory reclaiming work possible, by welding on high carbon cutting edge and point. The only equipment required besides an electric welder is an emery and buffing stand.

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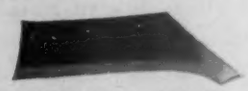
ELECTRIC  WELDED

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NEW PROCESS PLOW WELDING CO.

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